Utrecht University
Graduate School Natural Sciences

Programme Annex

to the

Education and Examination Regulations 2013-2014

Inhoud

Research Masters

Artificial Intelligence

Artificial Intelligence

Admission to the degree Artificial Intelligence

Applicants should possess solid basic knowledge of at least three of the following topics:

- logic as used in artificial intelligence, propositional and predicate logic and modal logic (modal reasoning);
- mathematics as used in artificial intelligence, including set theory, statistics (Bayesian networks), analysis (convergence) and linear algebra (robotics);
- programming languages as used in AI, in particular logic, imperative and object-oriented languages, and possess skills to develop and analyze programs in these languages;
- psychology of perception, and the anatomy and physiology of the brain;
- formal linguistics (syntax and semantics) and natural language processing;
- philosophy of cognitive science.

Furthermore, applicants should have the ability to communicate facts and findings verbally and in writing, also using information and communication technology and audio-visual means.

Applicants holding one of the following bachelor degrees are assumed to satisfy these requirements:

- A BSc in Artificial Intelligence from a Dutch University which is organized in KION (Kunstmatige Intelligentie Opleidingen Nederland);
- A BSc in Artificial Intelligence, Computer Science, Psychology, Philosophy or Linguistics from Utrecht University

Degrees in all probability meeting the above requirements are:

- A BSc with a major in Artificial Intelligence
- A BSc with a major in one of the following subjects, with some AI-related courses:
    - Cognitive Science
    - Computer Science
    - Linguistics
    - Philosophy
    - Psychology
- A Dutch HBO diploma in Computer Science with a suitable programme.

Learning outcomes

Knowledge and understanding
a) Mastery of artificial intelligence at an advanced academic level. This means mastery of a number of advanced general subjects in the areas of agents, cognitive processing and reasoning, and in depth-knowledge and ability in at least one advanced subject (such as agent design, multi-agent communication, multi-agent learning, cognition and language, psychology of perception, conceptual semantics, logic and computation, logic and language, or argumentation). Mastery of the necessary logical, computational and experimental tools. b) Thorough experience with research in (pure or applied) artificial intelligence and complete awareness of the applicability of research in technological developments and organizational contexts. c) Being able to read research articles in artificial intelligence.
Applying knowledge and understanding
a) Capable of understanding a wide variety of different research problems in 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, modeling and experimentation.

Making judgements

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 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

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.

Learning 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	22,5 ECTS
Primary electives	22,5 ECTS
Secondary electives	30 ECTS
Research part	45 ECTS
Total	**120 ECTS**

Format

Students can select one of three currently approved study paths:

- Agents
- Cognitive Processing
- Reasoning

Mandatory courses

Methods in AI Research (INFOMMAIR) (15 ECTS)
Philosophy of AI (WBMV05003) (7,5 ECTS)

Primary electives – mandatory per study path

Three courses per study path:

- Agents:
  - Intelligent Agents (INFOIAG)
  - Multi-Agent Systems (INFOMAS)
  - Multi-agent Learning (INFOMAA)
- Cognitive Processing:
  - Linguistics and Experimentation (TLMV13021)
  - Cognitive Systems (201300049)
  - Advanced Topics in Cognitive Science (201300050)
- Reasoning:
  - Logic and Language TLMV13020

- Commonsense Reasoning and Argumentation (INFOCR)
- Logic and Computation (WBMV13005)

Secondary electives

- Choice of all primary electives
- Research internship 7,5 ECTS (INFOMRIAI) or 15 ECTS (INFOMRIAI1)
- Free choice of courses from the UU master programmes Neuroscience and Cognition, Linguistics, Philosophy, Computing Science, Game and Media Technology.
- Choice of other master courses within or outside the UU (subject to approval; courses from other universities in the Netherlands or other countries must also be approved by the Board of Examiners.)

Students with deficiencies in the required entrance knowledge for the AI master programme can (subject to approval) use *at most* 15 ECTS to take courses (usually at the undergraduate level) to remedy those. For students with more deficiencies the board of admissions could, if feasible given the student's background and knowledge, offer the student a pre-master programme of 30 ECTS.

Research part

In the research part the student carries out a research project (INFOMAI) under the supervision of one of the staff members of the research groups offering the programme. The project is normally performed within the research group of the supervising staff member 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 AI programme director.

Chemical Sciences

Nanomaterials: Chemistry & Physics

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.
- The ability to work independently as well as in groups on solving chemical problems, present the results of solving problems and to read (English) chemistry literature at the level of graduate textbooks.
- Intermediate problem-solving skills in the main fields of chemistry and/or their applications.

Degrees in all probability meeting the above requirements are:

- 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.

Degrees in all probability meeting the above requirements are.:

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

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 five:

1) Physical Chemistry (classical and statistical thermodynamics),
2) Inorganic and Solid State Chemistry,
3) Spectroscopy and structural analysis,
4) Advanced organic chemistry and
5) Quantum Chemistry (Density Functional Theory).

-Prospective students must have acquired practical skills in the field of physical, inorganic and organic chemistry. Experience in writing in English 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, Keppler'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 judgments
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, 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 and 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 (C)	**Physical science courses (P)**	**Interdisciplinary courses (C/P)**
Advanced Organic Synthesis (SK-MOSS)	Soft Condensed Matter Theory (NS-TP453M)	Computational Quantum Mechanics (NS-NM431M)
Advanced Spectroscopy of Nanomaterials (SK-MASPN)	Photon Physics (NS-EP427M)	Soft Condensed Matter (NS-NM429M)
Solids & Surfaces (SK-MSOLS)	Simulation and Modelling (NS-TP432M)	Advanced Physical Chemistry (SK-MPC3)
Synthesis of Complex Nanostructures (SK-MSYNA)	Solar Energy Physics (GEO-2531)	Kinetics and Diffusion (SK-MKIDI)
Adsorption, Kinetics and Catalysis (SK-MAKC)		Topics in light and Electron Microscopy (NS-NM433M)
Organometallic Chemistry and Homogeneous Catalysis (SK-MOCHC)		

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 (not more than a maximum of 15 ECTS). The programme director decides which of the courses aiming to catch-up skills and/or knowledge 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.

Honours programmes

There are two honours programme developped within this master's degree programme and who fit within the frame work of the NWO graduate program. Their content and structure is shown below. The Debye honours programme is open for physics and chemistry students who want to excell at the interdisciplinary forefront offered by the physics and chemistry rsearch groups of the Debye Institute of Nanomaterials Science. Applicants are exptected to be international oriented. The Solar fuels honours programme is open for students with a chemistry background interested in sustainability in the field of catalysis and will perform their research project in collaboration with the Inorganic Chemistry group. Chemistry students can apply for both honours programmes. If selected for both programmes, only one option can be taken. Combination of both honours programmes is therefor not possible.

Debye Honours programme in Nanomaterials: Chemistry and Physics

Admission Criteria

The applicant should satisfy the admission criteria for the master programme Nanomaterials: Chemistry and Physics.
Moreover, the application will be reviewed by a selection-committee, consisting of representatives of the Debye Institute of Nanomaterials Science. The selection committee will base its decision on previous study results (top 10-20% of the BSc population), master results of the first term, motivation and the CV of the applicant. Admission to this programme is then foreseen at the latest in January following the September start and July for students entering the programme in February.

Contents

Mandatory courses	7,5 ects
Primary electives	22,5 ects
Secondary electives	45 ects
Research part	60 ects
Total	**135 ects**

Mandatory and primary electives

Honours students follow the mandatory course Nanomaterials: Catalysis, Colloids and Nanophotonics (SK-MNCCN) and take three courses (each 7,5 credits) from the Debye list of courses which is given in the programme description of the Nanomaterials: Chemistry and Physics programme. The marks for these courses should reflect that the honours students indeed belong to the top 10-20% of their year. Furthermore, for honours students who will graduate in Chemical Sciences, at least two courses with the label C/P or P, while for honours students who will graduate in Physics and Climate Science at least two courses with the label C/P or C. These label prerequisites can also be obtained by choosing secondary courses.

Secondary electives

Honours students are expected to take courses of 15 ects in addition to the primary courses. These courses are meant to fulfill the label requirements or can be chosen from another master's programme from Utrecht University or another university following the same criteria mentioned as for the internship. Permission could be granted to the honours student

when particular courses are needed that are not provided by the predefined course list. The programme director will evaluate the student's written motivation.

Honours students are also expected to perform an internship of 30 ects in highly ranked research groups (not including Utrecht University). Going abroad is highly stimulated. Alternatively the internship might be performed at an outstanding research laboratory of a multinational such as Philips, Shell, DSM, BASF.
The internship can only be started after the course work and the research project of 52,5 ects have been finished. The internship can also be used with the intention to start a PhD project in the Netherlands or abroad. The internship topic cannot coincide with the research project.

Research part

52,5 ects of the research will be devoted to a research project including the master's thesis, as in the regular programme. However to obtain the honours degree the student will additionally be involved in one of the two following options:

- 7,5 ects will be spent on writing a PhD proposal of a topic to be freely chosen by the honours student, that should however be interdisciplinary in nature. Supervision and coaching will be provided by two senior staff members which should be from different groups. Interdisciplinarity can also be established in a joint proposal with a supervisor from another Dutch university or research group, however the main supervisor should be located at Utrecht University. This proposal is eligible to compete in the Debye Graduate Program.
- Alternatively 7,5 ECTS can be spent on writing a research paper as a first author for an international peer-reviewed journal using the results of the master research project or the internship project that should be ready up to the level of submission. Supervision and coaching will be provided to guide the student through this process.
- Active participation in a conference/symposium will be encouraged if conference dates correspond to the period in which the research project is performed and the results are ready to be presented.

Honours programme in Solar Fuels

Admission Criteria

The applicant should satisfy the admission criteria for the master programme Nanomaterials: Chemistry and Physics.
Moreover, the application will be reviewed by a selection-committee, consisting of representatives of four universities namely Utrecht University, TU/Eindhoven, Leiden University and Twente University. 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's degree in Chemical Sciences or engineering with high grades.

Contents

Mandatory course	7,5 ects
Primary electives	22,5 ects
Secondary electives	45 ects
Research part	60 ects
Total	**135 ects**

Mandatory and primary electives (together 30 ECTS)

Honour's students follow the mandatory courses of 7,5 ECTS Nanomaterials: Catalysis, Colloids and Nanophotonics (SK-MNCCN) and three elective courses of each 7,5 ects to choose out of the list of predetermined courses within the Nanomaterials programme.

Secondary electives (together 45 ECTS)

This part is devoted to either specific courses in the field of Solar Fuels, composed of four courses given by each of the participating universities:

a. *Advanced Spectroscopy of Nanomaterials* (UU) (7,5 ECTS)
b. *Modern Concepts in Catalysis* (TU/e) (5 ECTS)
c. *Electrochemistry and Bioelectrochemistry* (UL) (5 ECTS)
d. *Photocatalysis* (UT) (5 ECTS)

and 22,5 ECTS internship project to be carried out in one of the participating research groups other than the group where the research for the master thesis is performed.

Research part

The Research project and thesis (60 ECTS) will be carried out in collaboration with one of the other participating research groups. The choice of topic and co-supervisor group does should not coincide with the internship.

Computer Science

Technical Artificial Intelligence

Admissions Criteria

Admission is closed as of 1 September 2013

Learning outcomes

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.
Applying 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.
Making judgements
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
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.
Learning 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	0,0 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 (WBFAI).
- 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:**
  - Program Verification (INFOPV)
  - Automatic Programme Analysis (INFOAPA).

Secondary electives

- 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 director. 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 projecs (INFOEPAT 7,5 ECTS, INOFEPAT1, 15 ECTS), to a maximum of 15 ECTS, either alone or with another student.

Subject to approval of the TAI programme director, 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 director.

Transition rules because of the merger of TAI and CAI

As of September 1st, 2013, the TAI programme will merge with the master programme Cognitive Artificial Intelligence into a new master programme Artificial Intelligence. As a consequence, two TAI courses, Multi-Agent Programming and Experimentation Project, will not be given any more after that date. TAI students who have Multi-Agent Programming on their study plan but have not yet completed this course by September 1st, 2013, can replace it with a Research Internship of 7,5 ECTS (INFOMRIAI) from the new AI programme, provided the topic is multi-agent programming. TAI students who have an Experimentation Project (7,5 or 15 ECTS) on their study plan but have not yet started it before September 1st, 2013, can replace it with a Research Internship of the same size (INFOMRIAI 7,5 ECTS or INFOMRIAI1 15 ECTS) from the new AI programme.

Game and Media Technology

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 in Computer Science or Artificial Intelligence
- 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;

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(..)-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

Knowledge and understanding
1. Can use his or her knowledge of computer science and its applications in the field of game and media technology 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 its applications in the field of game and media technology, and of indicating their implications for society and the research field.
3. Is capable of interpreting and using specialized literature in the field of game and media technology.
Applying knowledge and understanding
4. Is capable of translating a problem from the area of computer science and its applications in the field of game and media technology 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 responsability 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 and its applications in the field of game and media technology, 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 its applications in the field of game and media technology 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	0.0 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):

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,
INFOMGMAG games and agents,
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 (INFOCSM, 7.5 ECTS) on an approved subject.
Courses that remove deficiencies, as recommended by the programme director.

Research part

A small project of 15 ECTS	(INFOMSPGMT)
A thesis project of 42 ECTS	(INFOMGMT42)
A colloquium of 3 ECTS	(INFOMCQGMT3)

Legacy issues

The contents of a programme may partly consist of courses enumerated in previous versions of the programme specific part of the OER, pending approval by the programme director.

Computing Science

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 in Computer Science or Artificial Intelligence
- 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;

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, and
- 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 should satisfy these qualifications:

- UU BSc degree in Computer Science

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 BSc degree in Computer Science
- 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.

Within the master programme, at most two (bachelor-level) courses (15 ECTS) can be used to eliminate deficiencies in background knowledge. If the entrance requirements are not fully met by a student and the deficiency is larger, but motivation and other indicators are convincing, the Board of Admissions may allow a student to prepare for entrance by means of an individual pre-master programme of at most four (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's programme in 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 responsability 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	0.0 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 director. The following study paths are pre-defined and set the standard for the programme, 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 director.
The pre-defined study paths are:

- Programming technology:
  Advanced functional programming, compiler construction, program verification, theory of programming and types, automatic program analysis
- Algorithm design and analysis:
  Geometric algorithms, algorithms and networks, scheduling and time-tabling, dynamic programming, 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, pattern set mining

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 ETCS). 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

Advanced functional programming	(INFOAFP)
Algorithms and networks	(INFOAN)
Automatic program analysis	(INFOAPA)
Compiler construction	(INFOMCCO)
Data mining	(INFOMDM)
Dynamic Programming	(INFOMDP)
Evolutionary computing	(INFOEA)
Geometric Algorithms	(INFOGA)
Multimedia retrieval	(INFOMR)
Pattern recognition	(INFOMPR)
Pattern set mining	(INFOMPSM)
Probabilistic reasoning	(INFOPROB)
Program verification	(INFOPV)
Queries and retrieval	(INFOMQR)
Scheduling and time tabling	(INFOSTT)
Simulation	(INFOSIM)
Theory of Programming and Types	(INFOMTPT)

Information Science

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

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

- Advanced Research Methods (INFOARM)
- Method Engineering (INFOME)
- Knowledge Management (INFOKMT)
- Introduction to Business Informatics (INFOSPMBI)

Primary elective

-
- Business Informatics Summer School (INFOBISS)
- Business Intelligence (INFOMBIN)
- Enterprise Architecture (INFOEAR)
- Game Production (INFOMGPR)
- ICT Advisory (INFOMICTA)
- ICT Entrepreneurship (INFOIE)
- Seminar ICT in Life Sciences Innovations (INFOMILSI)
- Seminar Intelligent User Interfaces (INFOIUI)
- Seminar Medical Informatics (INFOMSMI)
- Seminar Serious Gaming (INFOMSEGA)
- Seminar Software Ecosystems (INFOMSSE)
- Software Architecture (INFOMSWA)
- Software Product Management (INFOMSPM)
- Sustainable Entrepreneurship (ECMSE)

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

History and Philosophy of Science

History and Philosophy of Science

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

Degrees in all probability meeting the above requirements are 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.

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

- 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
- Einstein, NS-HP440M
- History, Role, and Impact of the Social Sciences, OGMV05007
- History, Role, and Impact of the Biomedical Sciences, OGMV07003
- Origins, Knowledge, Society, OGMV13014
- Geschiedenis van de Moderne Natuurkunde, NS-361B
- History of Classroom Mathematics, WISL901
- Seminar History of Mathematics, WISM481
- Science in Islamic Civilization, WISM483
- Geschiedenis van de Wiskunde, WISB382
- Science and Epistemology III, WBMV09002
- Philosophy of Nature, WBMV13004
- The Foundations of Ethics, WBMV13002
- Models of Computation, WBMV09005
- CS Philosophy of Mind, WBMV05004
- Tutorial Foundations of Science, ZEMV06001
- Tutorial Foundations of Science, ZWMV07004
- 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 2011-2012 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 programme annex of the earlier applicable EER 2012-2013 remain valid. These provisions end on 31 August 2014.

Mathematical Sciences

Mathematical Sciences

Admission to the degree in Mathematical Sciences

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

- A 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, Computer Science or in Science with a strong component in Mathematics, which is comparable with the major part of the Utrecht University Bachelor "Wiskunde" or "Wiskunde en toepassingen".

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

The graduate of the master's programme has

Knowledge and understanding
1. theoretical and practical knowledge of advanced general concepts, principles and techniques of fundamental and applied mathematics; 2. an overview of the area of scientific research and development concerned; 3. 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
4. the skills to assimilate complex mathematical ideas and arguments; 5. the skills to identify, formulate, analyse and suggest independently possible solutions to problems in the field of mathematical sciences; 6. the skills to 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

Contents

Mandatory courses	7.5 ects
Primary electives	50.5 ects

Secondary electives	15 ects
Research part	47 ects
Total	**120 ects**

Mandatory Courses

Students must follow an advanced seminar in Mathematics or Theoretical Physics (at least 7.5 ECTS) in which they themselves have to give oral presentations.

Primary Electives

Primary elective courses are chosen from the course list given below or, if approved by the programme director, 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 leade 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 programme director. 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 foud at http://www.mastermath.nl. These rules apply fully to the rules of the University of Utrecht.

Mastermath courses 2013-2014

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)
Variational Methods (WISL408 , 8 ECTS)
Dynamical Systems (WISL404, 8 ECTS)
Elliptic Curves (WISL303 , 8 ECTS)
Probabilistic and Extremal Combinatorics (WISL708 , 8 ECTS)
Introduction to Stochastic Processes (WISL102 , 4 ECTS)
Riemann Surfaces (WISL514 , 8 ECTS)
Differential Geometry (WISL503 , 8 ECTS)
Measure-theoretical Probability (WISL701, 8 ECTS)
Asymptotic Statistics (WISL702, 8ECTS)
Parallel Algorithms (WISL603, 8 ECTS)
Numerical Linear Algebra (WISL601, 8 ECTS)
Continuum Mechanics (WISL428 , 8 ECTS)
Portfolio Theory (WISL709 , 8 ECTS)

Geometry (WISL507, 6 ECTS)
Stochastic Differential Equations (WISL108, 6 ECTS)
Advanced Modeling in Science (WISL203, 6 ECTS)
Applied Statistics (WISL106, 6 ECTS)
Applied Finite Elements (WISL204, 6 ECTS)
Infinite Dimensional Systems (WISL205, 6 ECTS)
Advanced Linear Programming (WISL105, 6 ECTS)
Scheduling (WISL107, 6 ECTS)
Queuing Theory (WISL108, 6 ECTS)
Category Theory & Topos Theory (WISL322, 8 ECTS)
Model Theory (WISL323, 8 ECTS)
Semidefinite Optimization (WISL111 , 8 ECTS)
Algebraic Geometry (WISL509, 8 ECTS)
Mathematical Biology (WISL411 , 8 ECTS)
Partial Differential Equations (WISL402, 8 ECTS)
Lie Groups (WISL500 , 8 ECTS)
Operator Algebras (WISL517, 8 ECTS)
Stochastic Processes (WISL703, 8 ECTS)
Time Series (WISL704, 8 ECTS)
Introduction to numerical bifurcation analysis of ODEs and Maps (WISL407, 8 ECTS)
Numerical Methods for stationary PDEs (WISL604 , 8 ECTS)
Historical Aspects of Classroom Mathematics (WISL909, 6 ECTS)
Moduli Spaces ((WISL52, 8 ECTS)
Rational Points on Varieties (WISL524, 8 ECTS)

SFM courses 2013-2014
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, 6 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)
Interest Rate Models WISS135, 6 ECTS)
Levy Fluctuation Theory with Applications in Finance and OR (WIS136, 6 ECTS)
Topics in Stochastic Networks (WISS138, 6 ECTS)
Statistical analysis of networks (WISS128, 6 ECTS)
Nonparametric Bayesian statistics (WISS129, 6 ECTS)
Statistical learning (WISS133, 6 ECTS)
Percolation theory (WISS115, 6 ECTS)
Probability seminar (WISS135, 6 ECTS)
Multivariate analysis and multidimensional data-analysis (WISS134, 6 ECTS)
Forensic statistics and graphical models (WISS109, 6 ECTS)
Ergodic theory and fractals (Seminar, WISS122, 6 ECTS)
Information-theoretic learning (WISS119, 6ECTS)

IAM courses 2013-1014

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 2013-2014

Laboratory Class Scientific Computing (WISM454, 7.5 ECTS)
Wavelets and Fourier transforms (WISM453, 7.5 ECTS)
Master student topics seminar on representation theory (WISM541, 7.5 ECTS)

Seminar History of Mathematics (WISM481, 7.5 ECTS)
Seminar Spin Geometry (WISM545, 7.5 ECTS)
Seminar on KdV (WISM536, 7.5 ECTS)
Seminar Differential Delay Equations (WISM537, 7.5 ECTS)
Seminar Fourier Analysis on Number Fields: Tate's Thesis on Zeta Functions (WISM522, 7.5 ECTS)
Seminar Hilbert's 10th Problem (WISM523, 7.5 ECTS)
Morse Theory (WISM511, 7.5 ECTS)
Introduction to symplectic geometry and Hamiltonian group actions (WISM510, 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.

Science Education and Communication

Science Education and Communication

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

Admissions Criteria

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

1. solid knowledge of one of the natural or life sciences at the level of a Dutch university Bachelor of science degree;
2. academic skills at the level of a Dutch university Bachelor of Science degree;
3. social and communicative competencies at a sufficient level to grow into a Science Education and Communication professional;

Bachelor degrees that satisfy the first two requirements are:

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

HBO graduates with a diploma in a relevant science or mathematics subject generally need to complete a pre-Master's programme of 30 ects in order to get admitted. A second degree teacher education (HBO tweedegraads lerarenopleiding) does not provide access to the programme.

Admission to the Science Education and Communication Programme does not automatically imply admission to the teacher education components of the programme. If the applicant indicated he would like to qualify for a teacher degree, additional requirements apply to determine eligibility for the teacher education components of the programme, both upon the content of student's prior education and upon social and communicative competencies:

- With regard to the content requirements (criteria 1 and 2), bachelor degrees that satisfy the content requirements are:
  - BSc degree in Biology (to qualify for a teacher certificate biology);
  - BSc degree in Chemistry (to qualify for a teacher certificate chemistry);
  - BSc degree in Physics (to qualify for a teacher certificate physics);
  - BSc degree in Mathematics (to qualify for a teacher certificate mathematics);
  - BSc degree in Computer Science or Information Science (to qualify for a 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 director 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.
- With regard to the third admissions criterion, in order to qualify for the teacher education components of the programme, applicants will have demonstrated social and communicative competencies at a sufficient level to grow into teacher in secondary education. An orientation course into educational practice (OCEP) with a positive recommendation will be regarded as evidence towards this criterion.
- Finally, for applicants who get admitted on the basis of a non-Dutch prior education, and who want to take the Dutch language version of the teacher education programme: fluency in Dutch at the level C1, according to the definitions of the Common European Framework.

For admission to the biology teacher education components of the programme, a numerical limitation applies because of limited placement opportunities for internships. Per starting moment (February, September) five positions for internships will be available. Upon admission to the programme, the admissions committee will rank the admissions requests for the biology teacher education components of the programme according to the knowledge

and skills of the applicants, and the admissions committee will admit applicants to those components of the programme on the basis of the rank order it has established (further information on the selection procedure can be found in the programme annex for 'Leraar Voorbereidend Hoger Onderwijs in [schoolvak]'). The admissions decision will specify a starting data for the teacher education programme. Any changes in that starting date require approval by the programme director. For the agreed starting date, the availability of an internship position will be guaranteed. If the student would like to start at a different date, or does not meet the entrance requirements at the preferred moment, the programme will try to accommodate this, but placement cannot be guaranteed at the preferred moment.

The regular version of the teacher education components is in Dutch. Students may opt for the English language version of the teacher education (U-TEAch) instead, but U-TEAch will have its own, competitive, application procedure. Admission to the programme Science Education and Communication does not imply admission to the U-TEAch programme (see section Contents for more information of this programma).

Learning outcomes[1]

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 Education and Communication at a level that enables them to function in a professional practice context; • 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.
Making judgements
Graduates are able to: • 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.
Communication
Graduates have the skills to: • 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.
Learning skills
Graduates are able to: • acquire and integrate new knowledge and competencies in science education and communication and in their disciplinary field; Graduates display attitudes that enable them to: • 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.

[1] *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.universitairelerarenopleidingen.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[2]:

Mandatory courses	**15 ECTS**
AS-SEC410- Introduction to Science Education and Communication	3,75 ECTS
AS-SEC411 - Public Science Communication with Multi Media	3,75 ECTS
AS-SEC412- Designing Science Education and Communication	3,75 ECTS
AS-SEC414 - Research Methods Science Education and Communication	3,75 ECTS
Primary electives	**30 – 60 ECTS**
Select one of the clusters below:	
Cluster A (60 ECTS)[3]	
Algemene Didactiek Start	4 ECTS
Algemene Didactiek 1	5 ECTS
Algemene Didactiek 2	5 ECTS
Theoretische Verdieping	4 ECTS
Praktijkgericht Onderzoek 1	5 ECTS
Masterstage 1	9 ECTS
Masterstage 2	8 ECTS
Vakdidactiek 1	4 ECTS
Vakdidactiek 2	4,5 ECTS
Praktijkgericht Onderzoek 2	2,5 ECTS
V-stage 1	4 ECTS
V-stage 2	5 ECTS
For students who start their teacher training in Feb 2014 or later[4], it is expected that that this cluster will be replaced by:	
Internship 1 (regular or U-TEAch)	15 ECTS
Internship 2 (regular or U-TEAch)	15 ECTS
Didactiek 1 (OSIRIS-code according to school subject)	7,5 ECTS
Didactiek 2 (OSIRIS-code according to school subject)	7,5 ECTS
PGO	7,5 ECTS
Elective[5]	7,5 ECTS
Cluster B (56,25 ECTS)[3]	
Algemene Didactiek Start	4 ECTS
Algemene Didactiek 1	5 ECTS
Algemene Didactiek 2	5 ECTS
Theoretische Verdieping	4 ECTS
Masterstage 1	9 ECTS
Masterstage 2	8 ECTS
Vakdidactiek 1	4 ECTS
Vakdidactiek 2	4,5 ECTS
V-stage 1	4 ECTS
V-stage 2	5 ECTS
AS-SEC415 - Advanced Topics in Science Education and Communication	3,75 ECTS
For students who start their teacher training in Feb 2014 or later[4], it is expected that that this cluster will be replaced by:	
Internship 1 (regular or U-TEAch)	15 ECTS
Internship 2 (regular or U-TEAch)	15 ECTS
Didactiek 1 (OSIRIS-code overeenkomstig schoolvak)	7,5 ECTS
Didactiek 2 (OSIRIS-code overeenkomstig schoolvak)	7,5 ECTS
AS-SEC415 - Advanced Topics in Science Education and Communication	3,75 ECTS
Elective[3]	7,5 ECTS

[2] *For students who started on the programme before September 2013, the curriculum requirements according to the EER 2012-2013 apply, provided that they graduate before 1 Oct. 2016.*
[3] *For selected students who take the U-TEAch variant, these courses will be replaced by the corresponding U-TEAch programme, including the "praktijkgericht onderzoek"*
[4] *the starting date for these new courses is conditional upon approval by the COLUU-board of directors*
[5] *for students who participate in the selective U-TEAch variant, additional requirements upon the choice of electives apply*

Cluster C (30-37,5 ECTS) AS-SEC413 - Innovation and Dissemination AS-SEC415 - Advanced Topics in Sci. Ed. and Comm. AS-SEC 420 - Professional Practice Internship	 3,75 ECTS 3,75 ECTS 22,5-30 ECTS
Secondary electives 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[6] 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 science master's programme. Acceptable choices include: 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 *Universitaire lerarenopleidingen Vakinhoudelijk masterniveau*). 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.	**15 - 30 ECTS**
Research part *Select one of the following options:* Research Project Science (in combination with cluster A) Research Project Science Education and Communication • (in combination with cluster B) • (in combination with cluster C)	**30 - 45 ECTS** 30[7] 30 45
Total	**120 ECTS**

[6] *The 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.*

[7] *If the set up of the research project will necessitate a project duration of 45 ECTS, the student can apply for an extension before the start of the project.*

Physics and Climate Science

Experimental Physics

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 and presenting the results 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.

Degrees in all probability meeting these requirements are

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

Admission to the programme

Students admitted to the Physics and Climate Science 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 Solid State Physics. Specifically, they should at least possess the following skills and knowledge:

Quantum Mechanics:
- The student knows the concept of spin and orbital angular momentum and can apply the rules for addition of angular momenta.
- The student understands and can apply time independent first and second order perturbation theory.
- The student can derive the eigenstates and eigenenergies of the harmonic oscillator

However it is strongly recommended to have knowledge of advanced quantum mechanics at the level of a third year bachelor's course.

Statistical Physics:
- The student can work in the canonical and the grand canonical ensemble
- The student knows the free energies associated with these ensembles
- The student can calculate the density of states in typical systems (massive/massless particles in a box)
- The student knows quantum statistics (Fermi-Dirac and Bose-Einstein) and can for instance apply it to calculate typical solid state problems, like the heat capacity in the Debye model.

Electromagnetism:
- The student knows and can apply important integral theorems (Green's, Stokes's, and Gauss's) to typical problems in electrostatics
- The student knows the Maxwell equations
- The student knows the constitutive relations between E and D, B and H
- The student can derive the wave equation

Furthermore, they should have the following skills and knowledge in either solid state physics or particle physics

Solid state physics:
- The student knows the relation between the crystal lattice and the reciprocal

lattice
- The student can calculate how phonons and electrons contribute to the heat capacity and heat/electrical conductivity
- The student understands the concepts of bandstructure and effective mass
- The student can derive optical properties from simple classical microscopic theories (Drude, Lorentz)

Particle Physics:
- The student understands the relation between symmetry and conserved quantities
- The student knows how radiation interacts with matter (Bethe-Bloch Equation, interactions of photons and electrons) and understands how the main particle detectors work (Time Projection Chamber, Silicon Detectors, Electromagnetic and Hadronic Calorimeters)
- The student can calculate scattering cross-sections (Rutherford, Mott)
- The students has a basic knowledge about the fundamental constituents of matter and their interactions (Feynman diagrams)

In case the student not taken one of the above mentioned subjects, it can be taken as part of the MSc programme to remedy this deficiency. The Board of Admissions will decide which topic need to be followed.

Learning outcomes

Knowledge and understanding
1a. Has basic knowledge of and insight into modern experimental physics with an emphasis on Particle physics and Atomic, Molecular and Optical (AMO) physics. 1b. Has profound knowledge of and insight into modern experimental physics with an emphasis on particle physics or AMO physics.
2a. Has knowledge on and experience with state-of-the-art experimental and data analysis techniques in particle physics and/or AMO physics. 2b. Can read and understand the professional literature in the fields of particle physics and/or AMO physics and to relate this to his/her own research.
Applying knowledge and understanding
3. Is able to identify, formulate, analyse and suggest possible solutions to problems in the field of particle physics or AMO physics.
4. Is able to conduct research in the fields of particle physics or AMO physics under supervision of a scientific staff member and report on it in a manner that meets the customary standards of the discipline.
5. Is able apply knowledge and insight in original experimental research projects in the area of particle or AMO physics, at the level of international scientific journals. 6. Is able to 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.
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 physics.
9. Is able to reflect critically upon his/her own contribution to particle physics and/or AMO physics, and that of others.
Communication
10. Has the skills to discuss, in spoken and written English, on the results of research, including the underlying knowledge and background.
11. Is able to work together constructively critical in an international team of experts and use modern means of scientific communication.
Learning skills

12a. Has the skills to work independently and take initiatives where necessary 12b has the skills to evaluate his/her own learning and development process and to adjust this process if necessary.
13. Is able to apply knowledge and insight in a way that demonstrates a professional approach to his or her work or profession.
14a. Has the qualifications to enrol in a PhD programme in the fields of particle physics or AMO physics. 14b. Is qualified to acquire a research position in a (semi) public or commercial organization.

Contents

Mandatory courses	22.5 ECTS
Primary electives	22.5 ECTS
Secondary electives	15 ECTS
Research part	60 ECTS
Total	**120 ECTS**

Mandatory courses

NS-PP403M	Particle Physics 1	6 ECTS
NS-EP427M	Photon Physics	7.5 ECTS
NS-EXxxxM	Experimental Quantum Physics	7.5 ECTS
Attendance Experimental Physics Colloquium		1.5 ECTS

Primary electives

A choice from the following list of courses, with at least 6 ECTS in Nikhef Master courses:

Utrecht courses

- NS-PP404M Particle Physics 2 6 ECTS
- NS-NM431M Advanced Quantum Modelling 7.5 ECTS
- NS-TP432M Modelling and Simulation 7.5 ECTS
- NS-TP401M Quantum field theory 10 ECTS
- NS-TP402M Statistical field theory 10 ECTS
- NS-PP402M Strong Interactions 6 ECTS

Shared Nikhef Master Courses

- NS-PP430M Beyond the standard model 3 ECTS
- NS-PP431M CP violation 3 ECTS
- NS-PP432M Gravitational waves 3 ECTS
- NS-PP428M Particle detection 6 ECTS
- NS-PP433M Programming C++ 3 ECTS
- NS-PPxxxM Computational methods 6 ECTS
- NS-PP427M Astroparticle physics 6 ECTS
- NS-PP434M Statistical Data Analysis 6 ECTS
- NS-PP429M Nikhef project 6 ECTS
- NS-PPxxxM CERN Summer Student Program 6 ECTS

Secondary electives

For the remaining 15 ECTS, several options are possible such as any MSc course offered by the Graduate Schools of Natural and Life Sciences or other courses with permission from the programme director, or an internship of at most 15 ECTS outside Utrecht University. Selection of courses should be discussed with the programme director. Internships can start as soon as the mandatory and primary elective courses have been finished, or sooner with permission of the programme director.

Secondary electives can also be those courses required to fulfil 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 courses with the permission of his/her supervisor. The research part consists of a thesis project of 60 ECTS. Research is usually done at the Particle Physics or Nanophotonics sections of the UU.

Special provisions for students enrolled in the programme Particle Physics in the year 2012-2013 and earlier

For students enrolled in the particle physics programme before September 2013, the programme annex of the EER 2012-2013 remains valid. These provisions end on 31st of August 2016.

Meteorology, Physical Oceanography and Climate

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 and presenting the results 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.

Degrees in all probability meeting these requirements are

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

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 with an MPOC-related minor and with knowledge of geophysical fluid dynamics are 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.

Secondary electives may be used for 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.

Learning outcomes

Knowledge and understanding
1a. Has knowledge of the physics of the climate system, as is described in the specific aims of the courses of the programme. 1b. Has a thorough understanding of the dynamics of atmosphere, ocean and climate.
2. Has knowledge of important developments in the field of global climate models and of process-oriented models and is able to state the relevance of these developments for the research field and society.
3. Has knowledge of the scientific literature in one of the five research themes of the programme.
Applying knowledge and understanding
4. Is able to define a scientific problem, formulate a research question and design a basic strategy to solve this problem.
5. Is able to develop a numerical model, and to use and improve (parts of) existing numerical models of different degrees of complexity.
6. Is able to analyse, process and interpret data from measurements and numerical modelling.
Making judgements

7. Is able to discuss at a professional level about scientific aspects of the climate.
8. Is able to indicate the relevance of the research field.
9. Is able to critically reflect on own results, as well as on published scientific literature in the field of climate dynamics.
Communication
10. Is able to transfer knowledge and results of scientific research in the field of climate dynamics to both a specialised and a more broadly interested audience.
11. Is able to professionally act in a (possibly multi-disciplinary) research team.
Learning skills
12. Has the skills to reflect upon his/her learning and evolution process and, if necessary, adjust this process.
13. Has developed an effective and result-driven working method that enables him/her to function in a self-reliant manner on a competitive labour market.
14. Has acquired sufficient scientific knowledge and skills to conduct independent scientific research, or to conduct other discipline-related work.

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

- Tipping points in the Climate System (NS-MO409M, 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)
- Wave Attractors (NS-MOxxxM, 7.5 ECTS)
- Remote sensing (NS-MO442M, 3.75 ECTS)
- Marine masters course (NS-MO446M, 3.75 ECTS)

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 45 ECTS 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

Students must have concluded at least two out of the three mandatory courses:

- Dynamical Oceanography (NS-MO401M),
- Dynamical Meteorology (NS-MO402M)
- Atmospheric Composition and Chemical Processes (NS-MO405M)

before commencing the master research project.

Nanomaterials: Chemistry & Physics

See programme description under Chemical Sciences

Theoretical Physics

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 and presenting the results 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.

Degrees in all probability meeting these requirements are

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

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.

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.

Knowledge and understanding
1a: Has basic knowledge of field-theoretic and mathematical methods in theoretical physics, and has insight into its use in high-energy physics and/or condensed matter physics and/or statistical physics. 1b: Can employ this knowledge to contribute to ongoing research in one of those areas.
2. Is aware of recent development in theoretical physics, and can put this into perspective of physics as a whole.
3. Is able to understand the international literature on at least one branch of theoretical physics, and to relate this to his/her own research.
Applying knowledge and understanding
4. Is able, possibly guided by a staff member, to translate a problem of modern theoretical physics into a research question.
5. Is able, under supervision of a staff member, to formulate a research plan that meets scientific standards.
6. Is capable to carefully conduct this research, supervised by a staff member, and to analyse and interpret the results obtained.
Making judgements
7. Can discuss the results of this theoretical research with the supervisor and fellow students, and possibly also with other researchers in the research group.
8. Can indicate the meaning and content of this research for the particular branch of theoretical physics.
9. Can critically reflect on this theoretical-physics research.

Communication
10. Can explain the results of this research to an audience of specialists as well as fellow students, both orally and in writing, in English.
11. Can conduct a theoretical-physics research project, supervised by a staff member, possibly as a part of (multidisciplinary) research team.
Learning skills
12. Has obtained the ability to study focused and independently.
13. Has an academic attitude towards the field of theoretical physics, which allows for further growth in this field or outside.
14. Is qualified to be admitted to a PhD research project in the field of theoretical physics, physics in general, and/or mathematics.

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**
- A Master level course in Mathematics* -General Relativity (NS-TP428M) -Cosmology (NS-TP430M) -String Theory (NS-5TP26M) -Modelling and Simulation (NS-432M) -Field Theory in Condensed Matter (NS-TP433M) -Kramers course -Soft Condensed Matter theory (NS-TP453M) -Field Theory in Particle Physics (NS-TP529M) -Theory for Technology**	-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 WISB342
- Complexe functies WISB311
- Topologie en Meetkunde WISB341
- Maat en Integratie WISB312

- Stochastische processen WISB362
- Distributies WISB
- Functionaalanalyse. WISB315

** In collaboration with the TU/Eindhoven

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.

Educatieve masteropleidingen

Leraar Voorbereidend Hoger Onderwijs in [schoolvak]

De in deze bijlage beschreven regelingen zijn van toepassing op alle programma's van de volgende opleidingen:

- Leraar Voorbereidend Hoger Onderwijs in biologie
- Leraar Voorbereidend Hoger Onderwijs in natuurkunde
- Leraar Voorbereidend Hoger Onderwijs in scheikunde
- Leraar Voorbereidend Hoger Onderwijs in wiskunde

Toelatingseisen

Toelaatbaar tot de opleiding is de bezitter van een Nederlands of een buitenlands diploma van hoger onderwijs, die aantoont te beschikken over de volgende kennis, inzicht en vaardigheden:

- vakinhoudelijke competenties op universitair bachelor- en masterniveau op het gebied van een voor het schoolvak relevante opleiding, waarvan de inhoud geheel of grotendeels betrekking heeft op hetzelfde wetenschapsgebied als het schoolvak en de verschillende leerdomeinen daarbinnen, waarvoor het desbetreffende programma opleidt zoals beschreven in de brochure *Universitaire lerarenopleidingen Vakinhoudelijk masterniveau* van de VSNU/ICL.[8]
- onderzoeksmatige competenties: domeinspecifieke onderzoeksmatige competenties op universitair masterniveau;
- academische competenties op het gebied van zoeken, selecteren en verwerken van literatuur, kritische reflectie op kennisbestanden, en mondelinge en schriftelijke weergave van deze reflectie en het zelfstandig en in teamverband kunnen werken op het hierboven genoemde niveau;
- sociaal-communicatieve en pedagogische competenties die nodig zijn om zich te kunnen ontwikkelen als docent in het voortgezet onderwijs en bereid zijn om te kijken naar het eigen gedrag als middel om communicatie te sturen, bijvoorbeeld blijkend uit een met positief advies afgeronde oriëntatiecursus (OCEP, COEP);
- Voor kandidaten die toegelaten worden tot het Nederlandstalige programma op grond van een niet-Nederlandstalige vooropleiding: beheersing van de Nederlandse taal op tenminste niveau C1, volgens de definities van het Europees referentiekader.

Aan de toelating van kandidaten met een andere vooropleiding dan door de opleiding gesteld kunnen specifieke voorwaarden verbonden worden in verband met het wegwerken van deficiënties. Deze worden vastgesteld aan de hand van de eindtermen zoals die zijn vastgelegd in de brochure *Universitaire lerarenopleidingen Vakinhoudelijk masterniveau.*

Toelating met deficiënties

De toelatingscommissie kan de kandidaat die al in het bezit is van een Nederlands universitair masterdiploma op diens verzoek toelaten tot de masteropleiding, indien:

- hij nog slechts onderdelen met een gezamenlijke studielast van ten hoogste 15 EC moet behalen om te voldoen aan de toelatingseisen, en
- er een studievertraging van een half jaar of langer zou optreden indien hij niet alvast aan de masteropleiding kan beginnen, en
- de gerechtvaardigde verwachting bestaat dat hij de betreffende onderdelen in zeer korte tijd, doch maximaal binnen een half jaar vanaf het moment dat student voorlopig is toegelaten tot de masteropleiding zal kunnen afronden.

De onderwijsonderdelen die nog behaald moeten worden om de deficiënties weg te werken worden in dat geval aan het examenprogramma toegevoegd, waardoor dit een omvang krijgt van maximaal 75 EC.

Numerieke beperking Leraar voorbereidend hoger onderwijs in biologie

[8] zie www.universitairelerarenopleidingen.nl.

De opleiding Leraar voorbereidend hoger onderwijs in biologie kent een numerus fixus:

- Het aantal beschikbare stageplaatsen bedraagt vijf per instroommoment.
- De toelatingscommissie brengt een rangorde aan tussen de ingediende verzoeken van toelaatbare kandidaten op basis van de kennis en vaardigheden van de verzoekers.[9]
- De toelatingscommissie willigt de verzoeken in volgens de door haar vastgestelde rangorde.

Numerieke beperking Variant Utrecht Teacher Education Academy (U-TEAch)

1. De door de opleiding geselecteerde student die een samenhangend geheel van onderdelen afrondt dat wordt verzorgd onder de aanduiding Utrecht Teacher Education Academy (U-TEAch), komt in aanmerking voor een certificaat waaruit blijkt dat hij zich gespecialiseerd heeft op het gebied van tweetalig en internationaal onderwijs.
2. Het onderwijs in de U-TEAch-variant kent één instroommoment per jaar.
3. De selectiecriteria voor toelating tot de variant U-TEAch en de inhoud van het programma staan beschreven in de paragraaf "Variant Utrecht Teacher Education Academy (U-TEAch)" .

Doel van de opleiding

Met de opleiding wordt beoogd:

- gespecialiseerde kennis, vaardigheid en inzicht op het gebied van het betreffende schoolvak, verdiepende en verbredende kennis van het vakgebied, en het voldoen aan de eindkwalificaties genoemd in het tweede lid.
- Voor deelnemers aan de variant U-TEAch bovendien: gespecialiseerde kennis, vaardigheid en inzicht op het gebied van tweetalig en internationaal onderwijs;
- voorbereiding op de beroepsuitoefening als eerstegraadsleraar in een van de bovengenoemde schoolvakken;
- voorbereiding op de beroepsuitoefening op het gebied van voorlichting, educatie en communicatie van het vakgebied, over vakwetenschappelijke onderwerpen en hun maatschappelijke context, in de educatieve sector, zoals bij educatieve diensten en didactische centra, bij uitgeverijen, in vakdidactisch onderzoek, voorlichting en journalistiek.
- afgestudeerden zijn vakinhoudelijk opgeleid op WO-masterniveau en hebben tijdens hun universitaire lerarenopleiding geleerd wat het betekent om in de uitoefening van hun beroep op dat niveau te functioneren.

De afgestudeerde:

- beschikt aantoonbaar over vakinhoudelijke en (vak)didactische kennis, inzichten en ervaringen die het bachelorniveau overtreffen dan wel verdiepen; maakt daar in de onderwijspraktijk kritisch gebruik van, en doet dat - al dan niet in onderzoeksverband - op een onderzoeksmatige manier, zodat hij bijdraagt aan het creëren van nieuwe kennis over schoolvak- en onderwijsontwikkeling.
- beschikt aantoonbaar over een adequate theoretische kennis op het gebied van communicatie, pedagogiek en onderwijskunde om op wetenschappelijk verantwoorde wijze bij te kunnen dragen aan het definiëren, analyseren en oplossen van problemen in het voortgezet onderwijs.
- is in staat om kennis, inzichten en probleemoplossende vermogens ook toe te passen in nieuwe of onbekende omstandigheden en bredere contexten, om nieuwe kennis te integreren en om met complexe materie en processen om te gaan.
- is in staat om oordelen te formuleren, ook op grond van onvolledige of beperkte informatie; om op basis van die oordelen te handelen en om daarbij rekening te houden met sociaal maatschappelijke en ethische verantwoordelijkheden die horen bij het vak en het beroep.

[9] De hiervoor gehanteerde procedure en criteria staan beschreven in bijlage 2.

- is in staat om kennis, motieven, overwegingen en daarop gebaseerde conclusies duidelijk en ondubbelzinnig over te brengen op diverse doelgroepen (leerlingen, collega's, ouders/verzorgers, specialisten/leken, binnen/buiten school)
- beschikt over vaardigheden die hem in staat stellen een vervolgstudie aan te gaan met een grotendeels zelfgestuurd of autonoom karakter.

De afgestudeerde van dit programma voldoet hiermee aan de bekwaamheidseisen voor een eerstegraads leraar VHO zoals beschreven in de Wet op de beroepen in het onderwijs (Wet BIO, 2006), en aan de daarvan afgeleide competenties zoals die beschreven staan in het landelijk overeengekomen uitstroomprofiel voor de Universitaire Lerarenopleidingen.[10]

De volgende tabel beschrijft de relatie tussen de eindtermen van de opleiding in de vorm van Dublin-descriptoren en de competenties uit het uitstroomprofiel voor de Universitaire Lerarenopleidingen.

[10] *Zie bijlage 1. Zie verder ook de brochure "Competentieprofiel van leraren die aan een ULO zijn opgeleid" op www.universitairelerarenopleidingen.nl*

	Kennis en inzicht	Toepassen kennis en inzicht	Oordeelsvorming	Communicatie	Leervaardigheden
Vakdidactisch deskundige					
- Heeft een expliciete visie op vak en plaats in maatschappij	X	X	X	X	
- Heeft inzicht in opbouw curriculum vak, inclusief kerndoelen en eindtermen	X	X			
- Weet hoe leerlingen kennis en begrip binnen vakgebied verwerven	X	X		X	
- Weet deze visie en inzichten te vertalen naar effectieve lessen		X		X	
- Durft te experimenteren					
Vormgever en begeleider van leerprocessen					
- Is in staat (op grond van doelen en beginsituatie) een systematische planning te maken van leeractiviteiten van leerlingen	X	X			
- Kan verschillende werkvormen adequaat hanteren	X	X		X	
- Is in staat aan leerlingen het hoe en waarom van een les duidelijk te maken	X	X	X	X	
- Kan omgaan met verschillen tussen leerlingen	X	X	X	X	
- Evalueert en toetst op een adequate manier de vorderingen van leerlingen	X	X		X	
- Zet op een effectieve manier diverse media hierbij in					
Pedagoog					
- Heeft voldoende zelfkennis, zelfwaardering en verantwoordelijkheidsgevoel om jongeren pedagogisch te begeleiden	X	X		X	
- Kan een gezonde relatie met jongeren aangaan in een sfeer van veiligheid en respect	X	X		X	X
- Is in staat vanuit pedagogisch perspectief te reflecteren	X	X	X	X	
- Kan stap voor stap een pedagogische visie ontwikkelen en geeft daarmee het pedagogisch – didactisch handelen richting					
Manager van de werksfeer					
- Heeft inzicht in communicatieprocessen in de klas	X				
- Beschikt over gedragsrepertoire om die processen te beïnvloeden en te sturen	X	X		X	
- Is in staat om in uiteenlopende omstandigheden een relatie met een groep leerlingen en met individuele leerlingen te onderhouden	X	X	X	X	
- Is in staat om een ordelijke en plezierige werksfeer te realiseren	X	X		X	
Docent in brede context					
- Toont zich ook buiten de klas (in brede context van de school) betrokken bij de school				X	X
- Voert ook in de schoolorganisatie les-, klas- en vakoverstijgende taken uit	X	X		X	
Docent die zelf verantwoordelijkheid neemt voor de eigen groei					
- Neemt initiatieven om het eigen handelen adequaat te analyseren	X	X	X		X
- Betrekt daar verschillende (theoretische) invalshoeken bij	X	X			X
- Past die toe op verschillende schoolsituaties	X	X	X		X
- Is in staat zich te verbeteren op basis van die analyse in een continu ontwikkelingsproces	X	X	X		X
- Kijkt op een onderzoeksmatige manier naar het beroep en werkveld					

Samenstelling programma's

Ieder van de programma's heeft een totale omvang van 60 ECTS en bestaat uit de volgende onderdelen:

Algemene Didactiek Start ..... 4 ECTS

Algemene Didactiek 1 ..... 5 ECTS
Algemene Didactiek 2 ..... 5 ECTS
Theoretische Verdieping ..... 4 ECTS
Praktijkgericht Onderzoek 1 ..... 5 ECTS
Masterstage 1 ..... 9 ECTS
Masterstage 2 ..... 8 ECTS
Vakdidactiek 1 ..... 4 ECTS
Vakdidactiek 2 ..... 4,5 ECTS
Praktijkgericht Onderzoek 2 ..... 2,5 ECTS
V-stage 1 ..... 4 ECTS
V-stage 2 ..... 5 ECTS

Voor studenten die in of na februari 2014 met de opleiding starten geldt, onder voorbehoud van definitieve goedkeuring door het COLUU-bestuur, de volgende programma-indeling:

Didactiek 1 (OSIRIS-code overeenkomstig schoolvak) ..... 7,5 ects
Didactiek 2 (OSIRIS-code overeenkomstig schoolvak) ..... 7,5 ects
Stage 1 ..... 15 ects
Stage 2 ..... 15 ects
Praktijkgericht onderzoek ..... 7,5 ects
Keuzevak (invulling ter goedkeuring van de examencommissie) 7,5 ects.

Variant Utrecht Teacher Education Academy (U-TEAch)

Doel
Binnen elk van de opleidingen bestaat de mogelijkheid de variant U-TEAch te volgen. U-TEAch is een traject voor excellente studenten, dat aangeboden wordt in samenwerking met het Europees Platform. U-TEAch bereidt voor op het lesgeven in het tweetalig onderwijs in Nederland en in het internationale onderwijs. Hiervoor wordt het U-TEAch certificaat uitgegeven. De student behaalt zijn reguliere Nederlandse eerstegraads onderwijsbevoegdheid.

Selectie
1. Voor het programma U-TEAch gelden als toelatingseisen:
   - een internationale oriëntatie;
   - een hoge motivatie;
   - uitstekende beheersing van het Engels. Dit wordt vastgesteld door middel van een test tijdens de selectieprocedure. Het vereiste niveau is CEFR-niveau B2+/C1;
   - de oriëntatiecursus moet bij voorkeur minimaal met het eindcijfer 8 zijn afgerond, of de kandidaat moet aantonen te beschikken over voldoende educatieve ervaring.
2. Er wordt een maximum aantal studenten per jaar toegelaten tot het U-TEAch programma. Het streven is jaarlijks rond de 20 studenten aan te nemen. Dit aantal wordt jaarlijks bepaald door het bestuur van het Centrum voor Onderwijs en Leren.
3. De U-TEAch selectiecommissie bepaalt de geschiktheid van de kandidaat op basis van de hierboven onder 1. vermelde criteria. Definitieve toelating geschiedt op basis van deze criteria, spreiding over de cursussen en beschikbare stageplaatsen in het buitenland.

Programma
Het onderwijs behorend bij de U-TEAch variant start eenmaal per jaar, in het najaar. Het programma omvat de volgende onderdelen met een totale omvang van 60 ECTS.

Algemene Didactiek Start ..... 2 ECTS
Algemene Didactiek 1 ..... 3,5 ECTS
Algemene Didactiek 2 ..... 3,5 ECTS
Theoretische Verdieping ..... 4 ECTS

Praktijkgericht Onderzoek 1 ..... 5 ECTS
Content and Language Integrated Learning ..... 2,5 ECTS
International Crosscultural education ..... 2,5 ECTS
Masterstage 1 ..... 9 ECTS
Masterstage 2 ..... 8 ECTS
Vakdidactiek 1 ..... 4 ECTS
Vakdidactiek 2 ..... 4,5 ECTS
Praktijkgericht Onderzoek 2 ..... 2,5 ECTS
V-stage 1 ..... 4 ECTS
V-stage 2 ..... 5 ECTS

Bijlage 1 – Uitstroomprofiel

De tekst in deze bijlage is overgenomen uit de brochure "Competentieprofiel van leraren die aan een ULO zijn opgeleid" van de ICL/VSNU[11]. Het volledige competentieschema waarnaar in de tekst wordt verwezen kan in de brochure gevonden worden.
De 7 competenties die in het schema beschreven worden zijn:

1. Interpersoonlijke competentie
2. Pedagogische competentie
3. Vakinhoudelijke en didactische competentie
4. Organisatorische competentie
5. Competentie: samenwerken met collega's
6. Competentie: samenwerken met de omgeving
7. Competentie: reflectie en onderzoek ten dienste van de eigen professionele ontwikkeling en de ontwikkeling van het schoolvak, het beroep en de school

Vakinhoudelijk opgeleid op WO-masterniveau en vakdidactisch specialist
Studenten die een ULO verlaten met een eerstegraads bevoegdheid, zijn academisch gevormd. Zij zijn vakinhoudelijk opgeleid op WO-masterniveau en hebben zich daarenboven tijdens hun universitaire lerarenopleiding bekwaamd in het lesgeven in dat vak aan leerlingen in het voortgezet onderwijs. Ze hebben zich gespecialiseerd in de vakdidactiek en verder alle competenties ontwikkeld die behoren bij het beroep van leraar, op een wijze die aansluit bij hun academische vooropleiding en bekwaamheden.

Startbekwaam op de zeven competenties
Studenten die een universitaire lerarenopleiding afsluiten met een eerstegraads bevoegdheid, zijn startbekwaam op microniveau (competentie 1 t/m 4 in het schema hierna), dat wil zeggen voldoende toegerust als leraar in hun vak voor alle leerlingen in het voorgezet onderwijs, van brugklas tot en met het eindexamen vwo. Zij beschikken over voldoende vakinhoudelijke en pedagogisch-didactische kennis en vaardigheden om recht te doen aan behoeften van leerlingen en verschillen tussen leerlingen en om zodoende een veilig leerklimaat te creëren. Ze weten hoe jongeren en adolescenten hun vak leren, kunnen de context analyseren waarbinnen dat gebeurt en beschikken over voldoende organisatorische vaardigheden om dat leerproces te doen plaatsvinden.
Eerstegraads leraren kunnen op basis van een adequate theoretische kennis op het gebied van communicatie, pedagogiek en onderwijskunde met klassen en met individuele leerlingen communiceren over hun schoolvak, over het leren op school en buiten school, over hun ontwikkeling en eventuele problemen daarin en verder over alles wat de leerlingen als jonge, opgroeiende mensen bezighoudt.
Naast startbekwaam op microniveau zijn studenten die universitaire lerarenopleiding afsluiten met een eerstegraads bevoegdheid, startbekwaam op twee andere terreinen.
Ten eerste hebben zij zich tijdens de opleiding ontwikkeld tot teamspelers, betrokken bij en actief in de schoolorganisatie. Ze zijn zich bewust van het belang van schoolontwikkeling en kunnen daar een rol in spelen. Ze zijn in staat samen te werken met collega's van het eigen vak (binnen en buiten school), maar ook met collega's van andere schoolvakken. Ze leveren in de samenwerking met collega's een professionele bijdrage aan een goed leef-, leer- en werkklimaat binnen school. Ook kennen zij hun verantwoordelijkheid tot samenwerken met de omgeving van de school en van de leerlingen en handelen zij daarnaar (competentie 5 en 6 in het schema hierna).
Ten tweede hebben zij zich tijdens de opleiding ontwikkeld tot bekwame ontwerpers en onderzoekers van onderwijs. Ze reflecteren op basis van actuele kennis op hun eigen onderwijs, het vak, het beroep en de school. Ze zijn in staat om op wetenschappelijk verantwoorde wijze problemen te definiëren en te onderzoeken en om oplossingen te ontwerpen en te evalueren, met gebruikmaking van actuele wetenschappelijke inzichten én moderne media. Ze houden

[11] Download van www.universitairelerarenopleidingen.nl

ontwikkelingen op hun vakgebied bij en vertalen deze naar de onderwijspraktijk. Ze nemen dus ook de verantwoordelijkheid voor hun eigen professionele ontwikkeling: zij zijn zich ervan bewust dat 'startbekwaam' betekent dat zij zich op alle terreinen nog verder zullen kunnen en moeten ontwikkelen (competentie 7 in het schema hierna).
Vanuit de hierboven beschreven academische achtergrond en startbekwaamheid zijn eerstegraads bevoegde leraren in staat om in het voortgezet onderwijs de volgende specifieke rollen te vervullen.

Een rolmodel voor leerlingen
Eerstegraads leraren inspireren leerlingen tot kennisverwerving door de manier waarop zij onderwijs geven: ze zijn een rolmodel voor leerlingen. Ze maken leerlingen nieuwsgierig naar de inhoud van het schoolvak en naar vakspecifieke probleemstellingen. Ze wekken belangstelling voor vormen van wetenschappelijk denken, al of niet via onderzoek, zoals via practica in bètavakken. Leraren tonen zich vakinhoudelijk zeer deskundig maar niet alwetend, laten twijfel toe en laten leerlingen zien dat oplossingen voor vakproblemen lang niet altijd vaste gegevens zijn, maar dat oplossingen gecreëerd worden en slechts gelden totdat er betere zijn.
Eerstegraads leraren zijn vindingrijk in het kiezen en vormgeven van aantrekkelijke leerstof en het ontwerpen van krachtige leeromgevingen. Ze dagen hun leerlingen daarmee uit. Ook laten zij hun leerlingen bijdragen aan de inhoud en vormgeving van het onderwijs: eigen probleemstellingen formuleren, zelf onderzoek uitvoeren, gegevens analyseren, interpreteren en presenteren. Het gebruik van de mogelijkheden van ICT hierbij is voor leraren en leerlingen steeds vanzelfsprekender. Eerstegraads leraren laten hun onderzoekende instelling aan leerlingen zien en putten daarvoor uit de actualiteit van alledag en uit de (gepopulariseerde) wetenschap.
In de bovenbouw havo-vwo krijgen leerlingen bij alle schoolvakken relatief omvangrijke, abstracte en complexe taken voorgelegd, die zij in toenemende mate zelfstandig en onderzoeksmatig leren uitvoeren. Eerstegraads leraren kunnen dergelijke taken ontwerpen, begeleiden en evalueren. Ze hebben daarbij oog voor het oproepen, begeleiden en evalueren van verschillende leerprocessen en voor transfer van het geleerde naar nieuwe situaties.

Een onderwijsontwikkelaar met collega's
Het ontwerpen en vormgeven van onderwijs zien eerstegraads leraren als een kwestie van onderzoek, als een proces van analyseren, ontwerpen, uitproberen, beschouwen, bijstellen en opnieuw beginnen. Eerstegraads leraren creëren onderwijs, zij laten het niet bij het uitvoeren van wat anderen bedachten. Zij delen met collega's op school – in de vaksectie, maar ook daarbuiten – hun ervaringen, hun bevindingen en hun expertise. Met collega's vormen deze leraren een op ontwikkeling gericht team, waarin creatief en kritisch, met distantie zowel als betrokkenheid, goed onderwijs wordt bedacht, uitgevoerd en geëvalueerd. Soms gebeurt dit systematisch, soms op goed geluk, maar steeds in overleg. Met collega's wordt zo een bijdrage geleverd aan de ontwikkeling van het onderwijs voor het schoolvak, binnen en buiten de school, en aan de didactiekontwikkeling in het algemeen. Deze leraren dragen hun keuzes en hun onderwijs uit, ook buiten de school, en zoeken voortdurend naar ideeën, inspiratie en vernieuwing. Kortom, zij dragen actief bij aan de professie.

De brug naar hoger onderwijs
Eerstegraads leraren vormen voor leerlingen – in havo en vwo direct; in (v)mbo wellicht indirect – de brug naar het hoger beroeps onderwijs en wetenschappelijk onderwijs. Die brug steunt op vier verschillende pijlers.
De eerste pijler is de vakmethodische pijler: leraren leren leerlingen vakgerichte vraagstukken onderzoeksmatig, kritisch en creatief te benaderen. Kernwoorden zijn hier: analyse, hypothese, bevinding, nuancering, synthese en toepassing. Kortom, eerstegraads leraren wijden leerlingen in in de denkwijzen en ontwikkelingen van de discipline(s) waarmee het schoolvak verwant is.
Een tweede pijler bestaat eruit leerlingen in te leiden in de principes van het schoolvak en hun belangstelling en enthousiasme ervoor te wekken. Eerstegraads

leraren onderwijzen leerlingen in de denkkaders van het schoolvak, met het eindexamen als uiteindelijk – maar niet enige – doel. De grondslagen of basisideeën van het vak helpen ook om actuele en historische verschijnselen waar te nemen, te ordenen, aan elkaar te relateren en te interpreteren. De basisprincipes van het vak bieden leerlingen een aantal zoeklichten op de werkelijkheid.
De derde pijler is die van zelfstandigheid. Leraren scheppen situaties waarin leerlingen kunnen leren zelfstandig te leren, inclusief het maken van fouten en het leren vermijden daarvan. Deze zelfstandige leerhouding wordt immers van meet af aan verlangd in het HBO en in nog sterkere mate in het WO.
En ten vierde: leraren stellen leerlingen in staat het vak serieus te betrekken in hun school-, profiel- en studiekeuze. Sommige leerlingen zullen het betreffende schoolvak op de universiteit willen gaan studeren. Eerstegraads leraren hebben dus weloverwogen ideeën over het belang van bepaalde vakonderdelen voor studie en beroep. Zij weten wat een vakstudie van leerlingen vraagt en kunnen leerlingen en hun ouders/verzorgers voorlichten over de beroepsmogelijkheden.
Ze zullen daartoe tenminste op hoofdlijnen wetenschappelijke ontwikkelingen binnen het vakgebied bijhouden.
En ook deze rollen vervullen ze op niveau.

Op WO-masterniveau
Eerstegraads bevoegde leraren beschikken over wetenschappelijke competenties, vakoverstijgende competenties en pedagogisch-didactische competenties. Zij zijn in staat professioneel te reflecteren op hun eigen functioneren en op hun omgeving. Zij kunnen op wetenschappelijk verantwoorde wijze problemen definiëren, analyseren en oplossen. Ze hebben een onderzoekende houding en zijn gericht op innovatie. Ze dragen actief bij aan het creëren van nieuwe kennis en aan schoolvak- en onderwijsontwikkeling. Ze nemen bovendien de verantwoordelijkheid voor hun eigen professionele ontwikkeling. Zij zijn vakinhoudelijk opgeleid op WO-masterniveau en hebben tijdens hun universitaire lerarenopleiding geleerd wat het betekent om in de uitoefening van hun beroep op dat niveau te functioneren. Ook wat dit betreft zijn zij na de opleiding startbekwaam en bereid en in staat om zich verder te blijven ontwikkelen.
Dit wil zeggen dat elke instelling die verantwoordelijk is voor universitaire lerarenopleidingen er op eigen wijze en via een eigen programma voor zorgt dat afgestudeerde eerstegraads leraren:

- aantoonbaar beschikken over vakinhoudelijke en (vak)didactische kennis, inzichten en ervaringen die het bachelorniveau overtreffen dan wel verdiepen, daar in de onderwijspraktijk kritisch gebruik van maken en dat - al of niet in onderzoeksverband - doen op een onderzoeksmatige manier zodat zij bijdragen aan het creëren van nieuwe kennis over schoolvak- en onderwijsontwikkeling.
- aantoonbaar beschikken over een adequate theoretische kennis op het gebied van communicatie, pedagogiek en onderwijskunde om op wetenschappelijk verantwoorde wijze bij te kunnen dragen aan het definiëren, analyseren en oplossen van problemen in het voortgezet onderwijs.
- in staat zijn kennis, inzichten en probleemoplossende vermogens ook toe te passen in nieuwe of onbekende omstandigheden en bredere contexten, om nieuwe kennis te integreren en om met complexe materie en processen om te gaan.
- in staat zijn om oordelen te formuleren, ook op grond van onvolledige of beperkte informatie, om op basis van die oordelen te handelen en om daarbij rekening te houden met sociaal maatschappelijke en ethische verantwoordelijkheden die horen bij het vak en het beroep.
- in staat zijn om kennis, motieven, overwegingen en daarop gebaseerde conclusies duidelijk en ondubbelzinnig over te brengen op diverse publieken (leerlingen, collega's, ouders/verzorgers, specialisten/leken, binnen/buiten school).
- beschikken over vaardigheden die hen in staat stellen een vervolgstudie aan te gaan met een grotendeels zelfgestuurd of autonoom karakter.

Bijlage 2 – Procedure selectieve toelating (art. 2.4)

De selectieve toelating, beschreven in deze bijlage, geldt voor de masteropleiding Leraar Voorbereidend Hoger Onderwijs in biologie en voor het traject met lesbevoegdheid biologie binnen de masteropleiding Science Education and Communication. De selectie is onderdeel van de toelatingsprocedure.

Selectiecriteria

- Afgeronde masteropleiding (voor de éénjarige lerarenopleiding), resp. bacheloropleiding (voor de master SEC) en geen vakdeficiënties op moment van start opleiding.
- Relevante ervaring/opleiding en goede beoordeling van bijv. oriëntatiecursus (COEP/OCEP), minor, hbo-lerarenopleiding, leservaring of werken met jongeren.
- Professionaliteit:
    - Goede communicatieve vaardigheden
    - Sociale wendbaarheid: kunnen werken in verschillende teams
    - Betrouwbaar zijn en afspraken nakomen
    - Vloeiende beheersing Nederlandse taal
    - Beschikbaarheid voor de opleiding (in tijd en prioriteiten).

Aan te leveren documenten

1) Motivatiebrief:
2) Twee brieven van aanbeveling
3) Een CV:
4) Bewijzen van relevante ervaring en goede beoordelingen:
5) Diploma's, overzicht vakkenpakketten en cijferlijsten:

Alleen complete dossiers worden in behandeling genomen.

Selectieprocedure

1e Selectie: op basis van bovengenoemde documenten wordt een rangorde aangebracht tussen de toelaatbare kandidaten. Daaruit komen twee categorieën:

(1) toelaatbaar en zonder meer plaatsbaar.
(2) toelaatbaar en niet zondermeer plaatsbaar: kandidaat wordt uitgenodigd voor een selectiegesprek.

2e Selectie: selectiegesprek in een groep met andere kandidaten.

Definitieve plaatsing gebeurt op basis van de bevindingen tijdens de 1e en 2e selectie en het intakegesprek, dat in veel gevallen ook deel uitmaakt van de toelatingsprocedure.

NB: Kandidaten voor de U-TEAch variant worden toegelaten via de selectieprocedure van U-TEAch.