



Universiteit Leiden

***Appendices to the
Course and Examination Regulations
Master's Programmes
Faculty of Science***

valid from 1 September 2021

Index

| | |
|-------------------------------------------------------|-----|
| Index | 2 |
| MSc Astronomy..... | 3 |
| MSc Bio-Pharmaceutical Sciences..... | 18 |
| MSc Biology..... | 38 |
| MSc Chemistry..... | 57 |
| MSc Computer Science..... | 70 |
| MSc Governance of Sustainability..... | 87 |
| MSc ICT in Business and the Public Sector..... | 93 |
| MSc Life Science and Technology..... | 100 |
| MSc Mathematics..... | 113 |
| MSc Media Technology | 121 |
| MSc Physics | 127 |
| MSc Statistics and Data Science | 146 |
| Specialisation Business Studies..... | 153 |
| Specialisation Science Communication and Society..... | 155 |
| Specialisation Education..... | 157 |

MSc Astronomy

CROHO-number 60200

1. Description of the programme (Course and Examination Regulations chapter 2)

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The aim of the Leiden Observatory MSc programme Astronomy is to provide students with the proficiency, experience and skills to pursue a successful career in science, or in companies, industry or society in general with a strong background in scientific thinking and understanding.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The programme offers seven specialisations, each comprising two years (120 EC): four research-oriented specialisations, and three combined specialisations.

The four research-oriented specialisations focus on major research themes including the evolution of the universe, the formation and evolution of galaxies, the birth and death of stars, the formation and occurrence of planets near other stars, astronomical instrumentation, and the analysis of very large and complex data sets. They allow the student to choose from either a broad research profile (“Astronomy Research” specialisation), or a profile that is more focused in a particular direction. The research-oriented specialisations offered (and described in detail below) are:

1. “Astronomy Research”;
2. “Astronomy and Cosmology”;
3. “Astronomy and Data Science”;
4. “Astronomy and Instrumentation”.

In addition to the research-oriented specialisations, three other specialisations are offered, which combine the main elements of the research curriculum with topics in Business Studies (BS), Science Communication and Society (SCS), and Education (EDU), and which are described separately.

Upon successful completion of the programme, students receive the degree Master of Science in Astronomy, with specification of the chosen specialisation.

All specialisations have the same Director, the same Programme Committee, the same Board of Examiners, and the same Board of Admissions. Exceptions to this are formed by the specialisations Business Studies, SCS, and EDU, which for the specialisation-specific part each have their own specialisation coordinator and a central Board of Examiners appointed by the Faculty of Science. Students with an MSc in any of the seven specialisations can be admitted to a PhD programme in Astronomy.

1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

The international standards for astronomy MSc programs are defined in the Domain Specific Reference Frame (DSRF). The DSRF is based on the “Tuning Physics” document, developed at the European level following the Bologna Agreements, which specifies how the general qualifications are translated into the program itself. The DSRF explicitly links to the five Dublin Descriptors and translates these into a number of specific competences, with corresponding achievement levels. The comparison between the learning outcomes of the program and the DSRF (and hence the Dublin

Descriptors) is presented below, which shows a detailed match between the learning outcomes of the program and the DSRF and Dublin Descriptors.

(A) KNOWLEDGE AND UNDERSTANDING

On completion of the programme, the student should:

- A1 have a good understanding of the important physical theories (logical and mathematical structure, experimental support, physical phenomena described).
- A2 be familiar with the most important areas of physics and with the common approaches, which span many areas in physics.
- A3 have a good knowledge of the state of the art in (at least) one of the presently active topics in physics research.

(B) APPLYING KNOWLEDGE AND UNDERSTANDING

On completion of the programme, the student should:

- B1 be able to frame, analyse and break down a problem in phases defining a suitable algorithmic procedure; be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems.
- B2 be able to identify the essentials of a process/situation and to set up a working model of the same; be able to perform the required approximations; i.e. critically think about how to construct physical models.
- B3 be able to understand and master the use of the most commonly used mathematical and numerical methods.
- B4 have become familiar with most important experimental methods and be able to perform experiments independently, as well as to describe, analyse and critically evaluate experimental data; and to be able to scientifically report the findings.
- B5 be able to use appropriate software, programming language, computational tools and methods in physical and mathematical investigations.
- B6 acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

(C) JUDGEMENT

On completion of the programme, the student should:

- C1 be able to develop a personal sense of responsibility; be able to gain professional flexibility through the wide spectrum of scientific techniques offered in the curriculum; be able to organize the personal learning process, evaluate personal work, consult experts for information (e.g. about career opportunities) and support when appropriate; have had the opportunity to take courses that prepare for teaching physics at secondary school, as well as the opportunity to gain in-depth interdisciplinary skills.
- C2 have become familiar with highly regarded research in the field, thus developing an awareness of the highest standards.
- C3 be able to understand the socially related problems related to the profession, and to comprehend the ethical characteristics of research and of the professional activity in physics and its responsibility to society; be able to conduct processes of decision making and inspect

the consequences of actions taking into account principles, norms, values and standards both from a personal and a professional standpoint.

- C4 be able to work with a high degree of autonomy, even accepting responsibility in (project) planning, and in the managing of structures.

(D) COMMUNICATION

On completion of the programme, the student should:

- D1 be able to listen carefully and to present difficult ideas and complex information in a clear and concise manner to a professional as well as to lay audiences; be able to work in a multidisciplinary or in an interdisciplinary team.
- D2 be able to read, speak, and write in technical English.

(E) LEARNING SKILLS

On completion of the programme, the student should:

- E1 be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.
- E2 be able to enter new fields through independent study; have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy (lifelong learning).
- E2 enjoy the facility to remain informed of new developments and methods, and be able to provide professional advice on their possible impact or range of applications.

The aforementioned qualifications, which are derived from the international domain-specific reference framework for Physics, apply to all specialisations of the MSc Astronomy. For the 4 research-oriented specialisations they are complete. The three society-oriented specialisations have the following additional qualifications:

| |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business Studies |
| BS1- Insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses; BS2- The ability to make a plan for a new business or an innovation project; BS3- Experience with performing business activities in an existing company or organization or directed towards technology-based business creation. |
| Science Communication and Society |
| SCS1- Knowledge of and skills in science communication theory and methods and is able to apply it; SCS2- Experience with science communication practice; SCS3- Knowledge of ethical, historical and social aspects in the area of the natural sciences. |
| Education |
| EDU1- all qualifications necessary for teaching all years of secondary education and technical and vocational training (students from 12 to 18 years old). |

The general qualifications of Faculty of Science are linked to the final learning outcomes of the programme as depicted below:

| | |
|--------------------------------------------|------------------------------------------|
| Final qualifications of Faculty of Science | Final learning outcomes MSc Astronomy |
|--------------------------------------------|------------------------------------------|

| | |
|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| A. Knowledge and understanding | |
| A graduate has: * the ability to interrelate and integrate various areas of the discipline; | A1, A2, and A3 |
| B. Applying knowledge and understanding | |
| * theoretical and/or practical skills in more than one specialist area of the discipline such that they can carry out research under overall supervision; * the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others; | B1, B2, B3, B4, B5, and B6 |
| C. Judgement | |
| * sufficient understanding of the social role of the natural sciences to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties; | C1, C2, C3, and C4 |
| D. Communication | |
| * the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication; | D1 and D2 |
| E. Learning (Skills) | |
| * the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous. | E1, E2, and E3 |

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February.

2. Curriculum (Course and Examination Regulations chapter 3)

The duration of the programme is two years (120 EC). For all specialisations, the selection of course work and research projects requires prior approval by the MSc Study Advisor. In individual cases a course from a different programme or field of study may be elected, but only after prior written approval from the Board of Examiners. In this case, the student should first discuss the course of choice with the MSc Study Advisor, and obtain agreement to proceed. Subsequently the chairman of the Board of Examiners may be contacted to seek the required official approval. At the start of the Master's Programme, the student and the MSc Study Advisor together draw up a complete list of planned courses and projects (the Master Study Plan). Changes in the Master Study Plan in the course of the programme are possible at any time, but always require prior approval by the Study Advisor.

2.1 Types of courses

A variety of courses is given each year. Specifics for all courses can be found in the Prospectus. Courses are given at different intervals: once per year, once per 18 months, once per two years, or at irregular intervals. Students must therefore always consult the long-term teaching schedule (which is published in the Prospectus and specifies the course schedule for the current and next year) when making their Master Study Plan. Courses are classified as follows:

Astronomy Core Courses (6 EC each): these are offered at regular intervals.

1. Origin and Evolution of the Universe 4303OEUNIY;

2. Large Scale Structure and Galaxy Formation 4303LSSG6Y;
3. Stellar Structure and Evolution 4303STEVOY;
4. Interstellar Medium 4303INTSTY.

Students (in any specialisation) who enrolled in the programme in February 2018 or earlier, may also chose the course “Galaxies: Structure, Dynamics and Evolution ” as a core course.

General Astronomy Courses (6 EC each): these vary with time, and are offered at regular or sometimes irregular intervals. Examples include:

1. Galaxies: Structure, Dynamics and Evolution 4303GSDE5Y;
2. Star and Planet Formation 4303STPLFY ;
3. Simulation and Modeling in Astrophysics (AMUSE) 4303SIMOAY.

Instrumentation-related Astronomy Courses (6 or 3 EC each): these vary with time, and are offered at regular or sometimes irregular intervals. Examples include:

1. Astronomical Telescopes and Instruments 4303AIAT6Y;
2. Detection of Light a 4303DETLAY (3 EC) or a+b (6 EC) 4303DETLAY+ 4303DETLBY;
3. Radio Astronomy 4303RADASY;
4. Astronomy from Space 4303ASFS3Y;
5. High Contrast Imaging 4303HCI03Y;
6. Project Management for Scientists 4303ASFS3Y.

Specialist Astronomy Courses (6 or 3 EC each): these vary with time and are offered at regular or irregular intervals; these courses provide in-depth introductions to specialised topics. Examples include:

1. Observational Cosmology 4303OBCOSY;
2. Astrochemistry 4303ASCHEY;
3. High-energy Astrophysics 4303HIENAY;
4. Gravitational Lensing 4303GRLENY;
5. Modern Astrostatistics 4303MOASSY;
6. Astronomical Spectroscopy 4303ASTSPY;
7. Numerical Recipes in Astrophysics 4303NRAPHY;
8. Exo-planets: Interiors and Atmospheres 4303EXPIAY.
9. Advanced Optical Systems

Non-Astronomy Courses; these must be selected from the courses offered by the Leiden MSc programmes in Physics, Mathematics, or Computer Science.

Astronomy Research Projects. Students in the specialisations “Astronomy Research”, “Astronomy and Cosmology”, “Astronomy and Data Science”, and “Astronomy and Instrumentation” carry out two astronomy research projects: the First Research Project and the Master’s Research Project. Students in the Business Studies, SCS or EDU specialisations carry out only the Master’s Research Project. All research projects have a total credit of 30 EC. For the First and Master’s Research Project, the total credit includes 27 EC Research and 3 EC Thesis.

All research projects are carried out under the supervision of a member of the scientific staff. The First and Master’s Research Projects must be on different topics. The Master’s Research Project can be started only after completion of the First Research Project (if that forms part of the programme). The maximum duration in calendar time of any Research Project is 9 months. However, if the First Research Project is started before November 1 of the first year, the deadline is extended to July 31

for students who started the programme in September. For students who started the programme in February this deadline is extended to December 31 if the First Research Project is started before April 1 of the first year.

In the specialisations Astronomy Research, Astronomy and Cosmology, Astronomy and Data Science, and Astronomy and Instrumentation, it may be possible to carry out the Master's Research project at a university abroad. This requires explicit permission from both the Study Advisor and Board of Examiners, and a Master Study Plan that allows for an extended stay abroad without causing delays to the study programme. Furthermore, it requires 2 supervisors: 1 in Leiden and 1 at the institute abroad. This option is only open to students who have no delays in their programme.

Every student should deliver a Student Colloquium, as listed in the programmes specified below. For the specialisations Astronomy Research, Astronomy and Data Science, Astronomy and Cosmology, Astronomy and Instrumentation, and Astronomy and Education, this colloquium should describe the Master's Research Project. For the other specialisations, the colloquium can describe either the Master's Research Project, or another research project or internship carried out in the context of the specialisation.

The following remarks apply for students who successfully completed:

- The Computational Astrophysics (6 EC) course, this is considered to be equivalent to the course Simulation and Modeling in Astrophysics (AMUSE) 4303SIMOAY (6EC).
- The Deep Learning and Neural Networks (6EC) course, this is considered to be equivalent to the course the Introduction to Deep Learning (6 EC).

3. Specialisation Astronomy Research

3.1 Description (Course and Examination Regulations chapter 2)

This 2-year programme consists of advanced Astronomy courses, two research projects in Astronomy, and courses on science topics related to the field of Astronomy. It allows the broadest programme, including a significant component from adjacent fields (Physics, Mathematics, and Computer Science). As such it prepares the student as much for a career in research as for a career outside academia.

3.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

| | Level | EC |
|--------------------------------------------------------|--------------|-----------|
| <i>Choice of</i> Astronomy core courses, at least: | 500 | 18 |
| <i>Choice of</i> Instrument-related courses, at least: | 400-500 | 6 |
| <i>Choice of</i> Astronomy courses of any type | 400-500 | 12 |
| <i>Choice of</i> Non-Astronomy courses | 400-500 | 24 |
| First Astronomy research project | 500 | 30 |
| Master's Astronomy research project | 600 | 30 |
| Student Colloquium | 600 | - |

The following remarks apply:

1. The First Research Project has to be done in the 1st year of the programme, while the Master's Research Project has to be done in the 2nd year.

2. One of the two courses “Science and the Public: Contemporary and Historical Perspectives” and “Science Methodology” may also be chosen as a non-Astronomy course.
3. The programme may be adapted for Master's students who have not followed the Leiden Astronomy Bachelor programme. Upon recommendation by the MSc Study Advisor and written approval by the Board of Examiners, the First Research Project can be reduced to a weight not smaller than 21 EC with a simultaneous increase in the number of courses in Astronomy. These additional courses can be selected from the normal courses in the Master's curriculum, and the BSc course Radiative Processes. These students may also add Astronomy courses at the cost of the non-Astronomy courses, in consultation with the MSc Study Advisor and approval by the Board of Examiners.
4. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course “Radiative Processes” or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.

4. Specialisation Astronomy and Data Science

4.1 Description (Course and Examination Regulations chapter 2)

The 2-year programme Astronomy and Data Science offers the student the option to follow a Research Master in Astronomy with a particular focus on the big data and computation aspects of both astronomy (as a data-rich science) and computer science. It prepares as much for a career in astronomy as in computational science, and for careers in research as well as outside research, in academia or elsewhere in society. It consists of advanced Astronomy courses, two research projects in Astronomy, and selected courses from the Computer Science MSc programme. This specialisation is offered by Leiden Observatory in collaboration with the Leiden Institute of Advanced Computer Science (LIACS) of Leiden University.

4.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) consist of 60 EC of courses, and 60 EC of research projects, as follows:

| | Level | EC |
|------------------------------------------------------------------|--------------|-----------|
| <i>Mandatory courses</i> | | |
| Modern Astrostatistics | 500 | 3 |
| <i>Choice of Astronomy core courses</i> | | |
| <i>Choice of Instrument-related courses</i> | 500 | 18 |
| <i>Choice of Astronomy courses of any type</i> | 400-500 | 3-6 |
| | 400-500 | 9-12 |
| <i>Choice of four of the following six courses (24 EC total)</i> | | |
| Simulation and Modeling in Astrophysics 4303SIMOAY (AMUSE) | 500 | 6 |
| Numerical Recipes in Astrophysics 4303NRAPHY | 500 | 6 |
| Advances in Data Mining (Computer Science) 4343ADVDMY | 500 | 6 |
| Introduction to Deep Learning (Computer Science) 4343INTDLY | 500 | 6 |
| Advances in Deep Learning (Computer Science) 4343SADL6Y | 500 | 6 |

| | | |
|------------------------------------------------------|-----|----|
| Reinforcement Learning (Computer Science) 4343REINLY | 500 | 6 |
| First Astronomy research project 4303FARP3Y | 500 | 30 |
| Master's Astronomy research project 4303MARP3Y | 600 | 30 |
| Student Colloquium 4303COLLQY | 600 | - |

The following remarks apply:

1. In the programme listed above, the courses labelled "Computer Science" are offered by the Leiden Institute for Advanced Computer Science.
2. The First Research Project has to be done in the 1st year of the programme, while the Master's Research Project has to be done in the 2nd year. The Master's Research Project must involve data manipulation (which may be simulated data) and/or data-related computational or statistical aspects.
3. One of the two courses "Science and the Public: Contemporary and Historical Perspectives", "Science Methodology" may also be chosen as a general/specialist/instrumentation Astronomy course.
4. The programme may be adapted for Master's students who have not followed the Leiden Astronomy Bachelor programme. Upon recommendation by the MSc Study Advisor and written approval by the Board of Examiners, the First Research Project can be reduced to a weight not smaller than 21 EC with a simultaneous increase in the number of courses in Astronomy. These additional courses can be selected from the normal courses in the Master's curriculum, and the BSc course Radiative Processes.
5. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course "Radiative Processes" or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.
Students who have started the specialisation 'Astronomy and Data Science' in 2019-2020 or before, are also allowed to choose the courses 'Advanced Data Management for Data Analysis' or 'Deep Learning and Neural Networks' as part of the 24EC Data Science course requirement.

5. Specialisation Astronomy and Instrumentation

5.1 Description (Course and Examination Regulations chapter 2)

The specialisation "Astronomy and Instrumentation" offers the student the option to conduct a Research Master in Astronomy with a particular focus on advanced astronomical instrumentation, techniques, and instrument development. It prepares the student as much for a career in research as for a career outside academia.

5.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

| | Level | EC |
|----------------------------------------------------|-------|----|
| <i>Mandatory Courses:</i> | | |
| Astronomical Telescopes and Instruments 4303AIAT6Y | 500 | 6 |
| Detection of Light a+b 4303DETLAY + 4303DETLBY | 500 | 6 |
| <i>Choice of Astronomy core courses, at least:</i> | 500 | 6 |

| | | |
|-----------------------------------------------------------------------------|---------|-------|
| <i>Choice of core/general/specialist Astronomy courses</i> | 400-500 | 24-30 |
| <i>Choice of instrumentation-related Astronomy courses</i> | 400-500 | 12-18 |
| First Research Project in Instrumental or General Astronomy 4303FARP3Y | 500 | 30 |
| Master's Astronomy Research Project in Instrumental Astronomy 4303MARP3Y | 600 | 30 |
| Student Colloquium 4303COLLQY | 600 | - |

The following remarks apply:

1. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course "Radiative Processes" or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.
2. The following courses offered by Delft University of Technology may be included as instrumentation-related courses in the above programme:
 - a. Space Instrumentation (AE4880, 4 EC)
 - b. Space Systems Engineering (AE4S12; 3 EC)
 - c. Geometrical Optics (AP3391; 6 EC)
 - d. Advanced photonics (AP3382; 6 EC)
 - e. Advanced Optical Imaging (AP3122; 6 EC)
3. Up to 12 EC of the general/specialist Astronomy courses may be replaced by non-astronomy courses, to be taken from the MSc programmes in Mathematics, Physics, or Computer Science; among these 12 EC the student may choose one of the two courses "Science and the Public: contemporary and historical perspectives", "Science Methodology".
4. The Master's Research Project may involve designing, building or testing of an instrument or instrument system, or any combination of these activities. It may be carried out in any of the Leiden Astronomy or Delft Technical Physics labs, or at external organisations directly involved in astronomical instrumentation.

6. Specialisation Astronomy and Cosmology

6.1 Description (Course and Examination Regulations chapter 2)

The specialisation "Astronomy and Cosmology" offers the student the possibility to conduct a Research Master in Astronomy with a particular focus on modern observational and theoretical cosmology. This specialisation is offered by Leiden Observatory in collaboration with the Institute Lorentz for Theoretical Physics in the Department of Physics at Leiden University (LION).

6.2 Programme (Course and Examination Regulations chapter 3)

The requirements for the programme (120 EC) are as follows:

| | Level | EC |
|-------------------------------------------------------|-------|----|
| <i>Mandatory Astronomy Courses:</i> | | |
| Origin and Evolution of the Universe 4303OEUNIY | 500 | 6 |
| Large Scale Structure and Galaxy Formation 4303LSSG6Y | 500 | 6 |

Choice of:

| | | |
|-------------------------------------------------------------------------------|---------|----|
| Astronomy core courses | 500 | 6 |
| Astronomy courses of any type | 400-500 | 18 |
| <i>Mandatory Physics Courses:</i> | | |
| Particle Physics and Early Universe 4403PPEU3Y | 500 | 3 |
| Origin and Structure of the Standard Model 4403OSSM3Y | 400 | 3 |
| Theory of General Relativity 4403TGR64Y | 400 | 6 |
| <i>Choice of:</i> | | |
| Related Physics courses | 400-500 | 12 |
| First Research Project in Cosmology <i>or</i> General Astronomy 4303FARP3Y | 500 | 30 |
| Master's Astronomy Research Project in Cosmology 4303MARP3Y | 600 | 30 |
| Student Colloquium 4303COLLQY | 600 | - |

The following remarks apply:

1. Students who have not followed the Leiden Bachelor programme and therefore not the BSc course "Radiative Processes" or an equivalent course, may take this course in the MSc programme, as a general or specialised astronomy course.
2. For students who successfully completed the 6 EC version of the course Particle Physics and the Early Universe (which was offered in previous years), this is considered to be equivalent to the 3 EC version plus the course Origin and Structure of the Standard Model.
3. Related Physics courses are Effective Field Theory, Quantum Field Theory, Statistical Physics, Topics in Theoretical Physics, Black Holes and Gravitational Waves, and Theoretical Cosmology.

7. Specialisation Business Studies

7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Business Studies (BS) offers students the possibility to combine astronomy with knowledge, insights and skills in the area of Management, Business, New Technology Ventures, and Entrepreneurship. Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Astronomy and Business Studies are admissible to a PhD programme in Astronomy.

7.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Business Studies (BS) programme consists of:

- a Master's Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
 - two Astronomy core courses; and
 - 6-12 EC of Astronomy courses related to the research topic; and

- 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science.
- a maximum of 20 EC of electives within either Astronomy or the BS component;
- a Student Colloquium, on either the Master's Research Project or the BS internship or research project.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

8. Specialisation Science Communication and Society

8.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Science Communication and Society (SCS) offers students the possibility to combine astronomy and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Astronomy and Science Communication and Society are admissible to a PhD programme in astronomy or in science communication.

8.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Science Communication and Society (SCS) programme consists of:

- a Master's Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
 - two Astronomy core courses; and
 - 6-12EC of Astronomy courses related to the research topic; and
 - 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science.
- a maximum of 20 EC of electives within either Astronomy or the SCS component;
- a minimum of 40 EC and a maximum of 60 EC of SCS specialisation components is required to complete the SCS specialisation. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).
- a Student Colloquium on either the Master's Research Project or on the internship or research project carried out for the SCS component of the programme.

The Science Communication and Society programme consists of the parts specified as follows:

| SCS Components | Level | EC | Catalog nr |
|----------------------------------------------|-------|----|------------|
| Informal Science Education* | 400 | 4 | 4603SCISEY |
| Policy & Development in science and Society* | 400 | 4 | 4603SCPDSY |
| Research in science communication* | 400 | 4 | 4603SCRSCY |
| Science Journalism (ENG)* | 400 | 4 | 4603SCSJ4Y |
| Wetenschapsjournalistiek (NL)* | 400 | 4 | 4603SCSWJY |
| Science Communication product development** | 400 | 4 | 4603SCPRDY |
| SCS: Scientific Narration and Visualization* | 500 | 3 | 4603SCNV3Y |
| Internship | | | |

| | | | |
|----------------------------|---------|-------|------------|
| SCS Project Proposal | 600 | 3 | 4603SCSPPY |
| SCS Internship(s) | 600 | 14-34 | 4603SCSS1Y |
| Additional elective | | | |
| SCS elective | 400-500 | 1-okt | 4603SCSELY |

* *SCS courses* are available as elective course for students who don't follow the SCS specialisation.

** the course **Science Communication product development** is only admissible for students who have completed all other SCS courses.

9. Specialisation Education

9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Astronomy and Education (EDU) prepares students for a career as physics (natuurkunde) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Astronomy and Education are admissible to a PhD programme in Astronomy.

9.2 Programme (Course and Examination Regulations chapter 3)

The Astronomy and Education (EDU) programme consists of:

- a Master's Research Project (30 EC) supervised by a member of the Leiden Observatory scientific staff;
- 30 EC of courses to be selected in correspondence with the research topic; these should at least include:
 - two Astronomy core courses; and
 - 6-12 EC of Astronomy courses related to the research topic; and
 - 6-12 EC of non-Astronomy courses, to be taken from the programmes of Physics, Mathematics or Computer Science.
- the Education component as described on [here](#).
- a Student Colloquium on the Master's Research Project.

The Astronomy component of the programme will be followed during the first year of study, the Education component will be followed during the second year.

When the student has passed the minor Education (30 EC) during the BSc programme, the compulsory Education component is reduced by 30 EC. The remaining 30 EC can be used for either the Astronomy or the Education component of the MSc programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

10. Admission to the programme (Course and Examination Regulations chapter 5)

10.1 Confirmation of admission

10.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 10.2 and 10.3, as long as the maximum number of students that

the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 10.2.1, the proof of registration is also confirmation of admission.

10.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.¹

10.2 Admission to the programme

10.2.1 In accordance to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Astronomy (Sterrenkunde) from a research university in the Netherlands, or
 - b) holders of a bachelor's degree in an astronomy-related programme from a research university in the Netherlands or from a foreign university of similar level, under the provisions mentioned below. For admission to any of the research-based specialisations of this master this under the provision that the bachelor's programme has provided the candidate with in-depth knowledge of undergraduate courses of the Astronomy curriculum (referred to under a.) with a theoretical and mathematical emphasis, including quantum physics, electrodynamics, statistical physics, and complex analysis. And with proficiency in programming, preferably in the Python language,
- or,
- c) holders of a bachelor's degree and additionally having passed the prescribed pre-master's programme pursuant to Article 10.4.1

10.2.2 The Board of Admissions may, upon request, admit persons to the programme who do not meet the requirements specified in 10.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 10.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 10.2.4.

Admission process

Applicants as referred to in Article 10.2.1.b and Article 10.2.2. are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 10.2.1.a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 10.2.1.a.

10.2.3 Dutch and English languages²

¹[Regulations for Admission to Master's Programmes](#)

² Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

10.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

10.2.3.2 If a student who wishes to be admitted does not meet the requirements in 10.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

10.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) – Gevorderd.

10.2.4 Qualitative admission requirements

10.2.4.1 In addition to the requirements specified in 10.2.1 and 10.2.2, the following qualitative admission requirements apply for the programme in accordance to Article 7.30b (2) of the Act:

For the specialisation "Astronomy and Cosmology" the following qualitative admission requirements apply:

- knowledge of "Physics of elementary particles" at undergraduate level is required.

For the specialisation "Astronomy and Data Science" the following qualitative admission requirements apply:

- Proven fluency in a 3rd generation programming language (e.g. Python, C++, ..) is required. Additionally, knowledge of "Statistics" at undergraduate level is required.

For the specialisation "Astronomy and Instrumentation":

- knowledge of "Solid state Physics" at undergraduate level is recommended (i.e. not an admission requirement)

10.3 Deficiencies

10.3.1 Holders of a bachelor's degree from a research university, referred to in 10.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

10.3.2 Students who still have the deficiencies referred to in 10.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

10.3.3 For the admission referred to in 10.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

10.3.4 If a student is admitted to the programme on the basis of 10.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

10.4 Bridging programmes (Pre-master's)

10.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- a. For students with a BSc degree in Aerospace Engineering from Delft University of Technology, the Pre-Master's programme will consist of the following elements from the BSc programme Astronomy:

| | Level | EC | Code |
|-------------------------------------|--------------|-----------|-------------|
| Stars | 300 | 5 | 4072STAR5Y |
| Galaxies and Cosmology | 300 | 5 | 4072GALC5Y |
| Astronomy Lab and Observing Project | 200 | 5 | 4072STRPRY |
| Astronomical Observing Techniques | 300 | 5 | 4072ASOT5Y |
| Quantum Mechanics 1 | 200 | 6 | 4062QUM16Y |
| Radiative Processes | 300 | 6 | 4072RAP63Y |

The course Quantum Mechanics 1 may be replaced by the two courses Kwantummechanica 1 (TN 2304; 3 EC) and Kwantummechanica 2 (TN 2314; 3 EC) offered at Delft University of Technology.

- b. For students with other bachelor's degrees the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

10.4.3 Information on the bridging programmes can be found on [Pre-Master's information page](#).

MSc Bio-Pharmaceutical Sciences

CROHO-number 60207

1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc programme Bio-Pharmaceutical Sciences (BPS) is taught in Leiden by the Leiden Academic Centre for Drug Research (LACDR).

The duration of the programme is two years (120 EC), independent of the specialisation.

Students who complete the programme receive the degree Master of Science in Bio-Pharmaceutical Sciences, with specification of the specialisation. Details are provided below.

All specialisations have the same Programme Director, the same Board of Examiners, and the same Programme Committee. A Board of Admissions will advise on admissions.

The specialisation-specific parts of Business Studies (BS), Science Communication and Society (SCS), and Education (EDU) have their own Programme Coordinator and Board of Examiners which is mandated by the Board of Examiners of Bio-Pharmaceutical Sciences. The Board of Examiners of BS and SCS is appointed by the Faculty of Science. The Board of Examiners of EDU (ICLON) is appointed by a composed board of multiple faculties.

Students who complete any of the specialisations in Bio-Pharmaceutical Sciences are admissible to a PhD programme in Bio-Pharmaceutical Sciences or other science disciplines.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The aim of the MSc programme BPS, organised by the Leiden Academic Centre for Drug Research (LACDR) of Leiden University, is to train students for a research career in drug research and development, not for a career as a (public) pharmacist. The general objective of the MSc programme BPS is to teach the master's student sufficient knowledge, insight, and skills to work independently at an academic level as a drug researcher, to contribute in an original manner to recognizing, introducing and solving questions in a specific knowledge area related to drug research, to discuss this contribution with experts in the field, to inform non-specialists about their ideas, goals and the public impact of their research.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme BPS offers seven specialisations. Three of these are research specialisations corresponding to major research themes at the LACDR: Drug Discovery and Safety, Systems Biomedicine and Pharmacology, and BioTherapeutics. The remaining four specialisations combine Bio-Pharmaceutical research with training in Business Studies (BS), Science Communication and Society (SCS), Education (EDU), or Industrial Pharmacy (IP).

1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc programme BPS have reached the following general achievement levels:

- a. Theoretical and practical skills in a specialist area of drug research such that (s)he can carry out research under overall supervision. Specifically, the graduate has knowledge and understanding of

- the core concepts and principles and recent developments a specialist area of drug research
 - and is skilled in commonly used and state-of-the art practical and/or computational research methods in a specialised area of drug research
 - the principles of responsible scientific conduct and the regulations in relation to his/her specialist drug research area.
- b. The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others. Specifically, the graduate is able to
- apply knowledge, insights and skills to work independently as a drug researcher at an academic level
 - contribute, in an original manner, to define and solve questions in a specific drug research knowledge area
 - draw up a research plan in which the research questions, the hypothesis and the experimental design are related to relevant literature and relevant previous research and is able to present and defend the plan against the opinion of professional colleagues
 - process, critically analyse, and interpret experimental and/or computational data.
- c. The ability to interrelate and integrate various areas of drug research. Specifically, the graduate is able to
- interrelate and integrate various areas of drug research and reflect on his/her research and that of others.
- d. The ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present his/her research results as a contribution to a congress or as (part of) a scientific publication. Specifically, the graduate is able to
- co-operate in a multi-disciplinary team on (bio)pharmaceutical-oriented research questions
 - participate in scientific discussions on drug research-related topics with scientific peers
 - provide a clear, structured oral presentation on the background, hypothesis, purpose of his/her research, experimental design, and on the obtained results, interpretation and conclusions, that is adjusted to the level of the target audience
 - communicate in writing on the background, hypothesis, purpose of his/her research, experimental design, and on the obtained results, interpretation and conclusions in the form of a scientific article according to the standards of an international peer-reviewed journal in the field.
- e. Sufficient understanding of the social role of drug research to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties. Specifically, the graduate is able to

- critically assess the significance for society and the applicability of his/her own research results and that of scientific literature
 - judge any conflicts of interest and other factors that may influence the trustworthiness of his/her research and/or the presentation of his/her research
 - judge and critically reflect on the scientific, ethical, societal and economic consequences of drug research.
- f. Learning skills to allow him/her to continue to study in a manner that may be largely self-directed or autonomous. Specifically, the graduate
- is able to study in a manner that is largely self-directed or autonomous and is able to make conscious choices for his/her own professional development
 - has the academic competences for employment as a drug researcher at an academic institution or in (bio)pharmaceutical/life science industry
 - is aware of the necessity to keep up-to-date on recent developments for his/her research.

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start with the MSc programme BPS in September or February. However, it is encouraged to start in September when the full introduction course is scheduled.

2. Admission to the programme (Course and Examination Regulations chapter 5)

2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.³

2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Bio-Pharmaceutical Sciences (Bio-Farmaceutische Wetenschappen) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a programme related to Bio-Pharmaceutical Sciences from a research university in the Netherlands or from a foreign research university of similar level,

³[Regulations for Admission to Master's Programmes](#)

provided that the candidate has accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Bio-Pharmaceutical Sciences and has had basic research training in the field of life science including a 16 EC, level 400 (or equivalent) final research assignment, covering all aspects of the research cycle and being concluded with a research thesis written in academic English, and an oral presentation.

Article 2.2.1 b may, amongst others, apply to holders of a degree from a research university in Biology, Biomedical Sciences, Chemistry, Informatics with the specialisation Informatics & Biology, Life Science and Technology, and Pharmaceutical Sciences. The type of specialisation may be restricted depending on the prior education.

For the Education (EDU) specialisation, Master's students in Bio-Pharmaceutical Sciences of Leiden University with a BSc degree in Bio-Pharmaceutical Sciences as well as those with a BSc degree in Pharmaceutical Sciences, Pharmacy, Molecular Science & Technology, Chemistry or Life Science & Technology or an equivalent degree of a Dutch university will be considered for admission. The teacher educator of Chemistry respectively Biology will assess if there are deficiencies in the prior education of the student. When deficiencies are identified, the teacher educator will propose how these can be solved.

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in Chemistry or Biomedical Sciences (or equivalent field of science). As a guideline for applicants with a degree from a Dutch University of Applied Sciences (hbo/HLO), the degree must have been obtained within four years with a grade point average (GPA) above 7.5. In addition, the research project that was included in the (hbo/HLO) programme must have been conducted at a research university or a university medical centre and must have been assessed with a grade above 8.0 (grades according to the Dutch grading scale).

Admission process

Applicants as referred to in Article 2.2.1.b and Article 2.2.2. are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- curriculum vitae (resume)
- bachelor's thesis/report of final project in English
- a placement letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1.a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1.a.

The research specialisations are considered to be default specialisations. Therefore, students will initially only be admitted to the MSc programme BPS for a research specialisation. Students opting for a non-research specialisation will be admitted after the successful completion of their first year of

the MSc programme BPS (see also 3.1). Students opting for the research specialisations continue their research training in the second year.

2.2.4 Dutch and English languages⁴

2.2.4.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

2.2.4.2 If a student who wishes to be admitted does not meet the requirements in 2.2.4.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing, and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

2.2.4.3 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL (Toelatingsexamen Universiteit Leiden) - halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. This applies to the IP specialisation of the MSc programme BPS.

The Education specialisation of this master's programme sets the following Dutch language requirements: TUL-gevorderd.

2.2.5 Maximum capacity

2.2.5.1 If the Executive Board has determined a maximum capacity for the programme, the order of admission will be determined by the qualitative admission requirements as referred to in sub-article 2.2.5.3.

2.2.5.2 Admission to the specialisation in Industrial Pharmacy is limited to two students in the academic year 2021-2022.

⁴ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

2.2.5.3 Where article 2.2.5.1 applies, the method of selection on the grounds of the criteria will be as follows:

Master's students in Bio-Pharmaceutical Sciences of Leiden University will be considered for admittance to this specialization in Industrial Pharmacy of the programme if they meet the following minimum requirements:

- a BSc degree in Bio-Pharmaceutical Sciences, Pharmaceutical Sciences or Pharmacy
- proficiency in Dutch (native speaker or TUL halfgevoerd (= staatsexamen NT2-II)).
- An average grade of 7.5 or higher for the components Practical work, Report and Oral presentation of Research Project 1.

Additionally, the Board of Admissions will judge the candidate's personal skills for qualification to the specialisation based on the following criteria:

- awareness of responsibility (20%)
- accuracy (20%)
- communication skills (20%)
- methodological approach when analyzing complex problems (20%)
- motivation (20%)

The selection for this specialisation takes place in Spring. Students must apply by writing a motivation letter. In addition, a recommendation letter of the examiner of Research Project 1 should be included reflecting on the above mentioned criteria. The Board of Admissions will invite students, who meet the requirements, for an interview after which it makes the final selection based on the criteria indicated above. The standard norm used for assessment of the criteria and the assessment scale are provided in the module "MSc Bio-Pharmaceutical Sciences" in the learning management system.

2.2.5.4 Where article 5.2.5.1 applies, the deadlines for selection are as follows:

Application for the master specialisation Industrial Pharmacy, starting in September 2021 or September 2022 should be done before April 1, 2021 or April 1, 2022, respectively. A conditional decision on admission to the specialisation Industrial Pharmacy will be made after completion of at least half (≥ 21 EC) of the research project at one of the Divisions of the LACDR and communicated to the applicant within 1 week of the interview. If the student meets the requirements, the admission becomes unconditional after completion of Research Project 1.

2.2.6 Qualitative admission requirements

Not applicable.

2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

2.4 Bridging programmes (Pre-master's)

Not applicable.

3. Examinations, Final Examination (Course and Examination Regulations chapter 4)

3.1 Obligatory sequence (Course and Examination Regulations art. 4.2)

3.1.1 Students may only take the following courses and sit their attendant examinations once they have passed the examinations for one or more other components:

| Programme component | Follow course and sit its attendant examination after having passed |
|----------------------------------------------|--------------------------------------------------------------------------------------------------|
| Research project 1 | Written research project proposal as part of the Introduction course, laboratory safety training |
| Literature study | Research project 1 |
| Specialisation components | Research project 1 |
| Internship Quality Control/Quality Assurance | Essay Quality Control/Quality Assurance |

3.1.2 For the components and their attendant examinations which must be completed in a given sequence, the Board of Examiners may in special cases, and following a substantiated written request by the student, agree to an alternative sequence.

4. Programmes of the specialisations

Below the programmes of the individual specialisations are described.

The study programme components of each individual student are recorded with a special appointment form (Form 2 Masters of Science Document) in and must be approved by the study advisor before starting with the individual components. For elective components approval by the Board of Examiners must be demonstrated for approval.

The format requirements and guidelines for supervision and assessment of individual programme components are published in the online module "Master Bio-Pharmaceutical Sciences" in the learning management system. Every student, daily supervisor, and responsible examiner is expected to have studied these guidelines before the start of the programme component.

4.1. Specialisation Drug Discovery and Safety

The MSc specialisation Drug Discovery and Safety offers research-orientated education into the discovery of new drug targets and new lead molecules, particularly in the field of cancer. For identification of novel drug targets and development of novel, effective and safe drug leads students are trained in advanced imaging techniques ('systems microscopy'), in vitro and in vivo model systems, organic synthesis, molecular biology, pharmacology, and computational approaches (chem- and bioinformatics and computational biology). The Division Drug Discovery and Safety of the LACDR, and the Division of Bio-organic Synthesis and Molecular Physiology of the Leiden Institute of Chemistry (LIC), are involved in the MSc specialisation Drug Discovery and Safety. Admission to this specialisation may be restricted by available places.

Students who complete the specialisation Drug Discovery and Safety are admissible to a PhD programme in bio-pharmaceutical sciences or related science disciplines.

4.1.1 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme BPS with the specialisation Drug Discovery and Safety

1. have obtained in-depth knowledge of a specific subject related to the discovery of novel drug targets or new lead molecules.
2. have obtained theoretical and practical skills in a second specialist area of drug research.
3. have deepened and extended learning outcomes 1.3a-d by performing a second research project.
4. are able to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature.

4.1.2 Programme (Course and Examination Regulations chapter 3)

The Drug Discovery and Safety (DDS) programme consists of General BPS research components, specialising in Drug Discovery and Safety (55 EC), deepening research specialisation components (43 EC), and compulsory (7 EC) and optional (15 EC) programme components as specified below.

| | Level | EC | Course code |
|-----------------------------------------------------------------------------------|-------|----|-------------|
| General BPS research components, specialising in Drug Discovery and Safety | | | |
| Introduction Course BPS: Drug Discovery and Safety | 500 | 4 | 4323ICORV |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, in research area of DDS | | | |
| • Literature research, practical implementation and | 600 | 44 | 4323RPR44 |
| • Thesis | 600 | 5 | 4323RP1TH |
| • Oral presentation | 500 | 2 | 4323RP1OR |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCO |
| Research specialisation components | | | |
| Research Project 2, in a second area of drug research | | | |
| • Literature research, practical implementation and | 600 | 31 | 4323RP2X9Y |
| • Thesis | 600 | 5 | 4323RP2THY |
| Literature Study, including literature research and literature study | 500 | 7 | 4323LISTTY |
| Electives | | | |

Optional courses or BPS traineeship ≥400 15

Research Project 1

Research Project 1 must be conducted within the Division Drug Discovery and Safety of the LACDR, or at the LIC under supervision of a LIC staff member appointed by the Board of Examiners. Research Project 1 can also take place in the research area of Drug Discovery and Safety at external research groups to which LACDR professors are affiliated or, after approval by the Board of Examiners, at other research groups under the supervision of a staff member of the LACDR.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course “Fish species in animal experimentation” (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

Research Project 2

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or, at the Center for Human Drug Research, the Leiden University Medical Center, other Science Faculties, University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Programme Director *before the start* of the project.

Literature Study

The Literature Study must be conducted under supervision of a staff member of LACDR who is from a different Principal Investigator group and has not been affiliated with Research Project 1 or 2. The aim of the literature study is to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature. Therefore, the subject of the Literature Study must be different from that of Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study must be carried out within a period of seven consecutive weeks, equivalent to 5 weeks full time, and can therefore not be combined with other programme components. In exceptional cases, the Board of Examiners may decide to grant a student permission to combine the literature study with other programme components. The Literature Study is completed with a written literature study paper.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lecture series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

Electives

The optional part of the programme can consist of additional BPS Lecture series, master’s courses of level 400 or higher offered at a Science or Medical Faculty of any Dutch or foreign university, or a traineeship. For courses outside the Faculty of Science of Leiden University approval by the Board of Examiners is required. In exceptional cases, the Board of Examiners may decide to grant an exemption for courses <400 level or for courses of which the level is not explicitly provided. A list of approved elective courses is available in the online module “MSc Bio-Pharmaceutical Sciences” in the learning management system. A student may be awarded credits for acting as an assistant in courses

of the Bio-Pharmaceutical Sciences bachelor programme, in proportion to the course load and pending permission from the Board of Examiners, obtaining an ICLON certificate for a didactic skills training, and the completion of a report with a reflection on the provided education. Costs for following elective courses or traineeships are borne fully by the student.

A more comprehensive description of the programme can be found in the prospectus.

4.2. Specialisation Systems Biomedicine and Pharmacology

The MSc specialisation Systems Biomedicine and Pharmacology offers research-orientated education into understanding and predicting drug-induced modulation of disease networks at the systems level. Systems Biomedicine and Pharmacology offers a unique combination of cutting-edge experimental training in the field of metabolomics and translational systems biology as well as quantitative pharmacology education in the area of computational modelling of pharmacokinetic and pharmacodynamic (PK/PD) relationships. The Division Systems Biomedicine and Pharmacology of the Leiden Academic Centre for Drug Research, and the Center for Human Drug Research (CHDR), are involved in the MSc specialisation Systems Biomedicine and Pharmacology. Admission to this specialisation may be restricted by available places.

Students who complete the specialisation Systems Biomedicine and Pharmacology are admissible to a PhD programme in bio-pharmaceutical sciences or related science disciplines.

4.2.1 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Systems Biomedicine and Pharmacology

1. have obtained in-depth knowledge of a specific subject related to the understanding or the predicting of drug-induced modulation of disease networks at the systems level.
2. have obtained theoretical and practical skills in a second specialist area of drug research.
3. have deepened and extended learning outcomes 1.3a-d by performing a second research project.
4. are able to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature.

4.2.2 Programme (Course and Examination Regulations chapter 3)

The Systems Biomedicine and Pharmacology (SBP) programme consists of General BPS research components, specialising in Systems Biomedicine and Pharmacology (55 EC), deepening research specialisation components (43 EC), and compulsory (7 EC) and optional (15 EC) programme components as specified below.

| | Level | EC | Course code |
|----------------------------------------------------------------------------------------------|-------|----|-------------|
| General BPS research components, specialising in Systems Biomedicine and Pharmacology | | | |
| Introduction Course BPS: Systems Biomedicine and Pharmacology | 500 | 4 | 4323ICORV |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, in research area of SBP | | | |
| • Literature research, practical implementation and | 600 | 44 | 4323RPR44 |
| • Thesis | 600 | 5 | 4323RP1TH |

| | | | |
|-------------------------------------------------|-----|---|-----------|
| • Oral presentation | 500 | 2 | 4323RP1OR |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCO |

Research specialisation components

Research Project 2, in a second area of drug research

| | | | |
|----------------------------------------------------------------------|-----|----|------------|
| • Literature research, practical implementation and | 600 | 31 | 4323RP2X9Y |
| • Thesis | 600 | 5 | 4323RP2THY |
| Literature Study, including literature research and literature study | 500 | 7 | 4323LISTTY |

Electives

| | | | |
|-------------------------------------|------|----|--|
| Optional courses or BPS traineeship | ≥400 | 15 | |
|-------------------------------------|------|----|--|

Research Project 1

Research Project 1 must be conducted within the Division Systems Biomedicine and Pharmacology of the LACDR, or the CHDR. Research Project 1 can also take place in the research area of Systems Biomedicine and Pharmacology at external research groups to which LACDR professors are affiliated or, after approval by the Board of Examiners, at other research groups under the supervision of a staff member of the LACDR.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course “Fish species in animal experimentation” (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

Research Project 2

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or in another MSc programme, or at the Center for Human Drug Research, the Leiden University Medical Center, other Science Faculties, University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Programme Director *before the start* of the project.

Literature Study

The Literature Study must be conducted under supervision of a staff member of LACDR who is from a different Principal Investigator group and has not been affiliated with Research Project 1 or 2. The aim of the literature study is to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature. Therefore, the subject of the Literature Study must be different from that of Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study must be carried out within a period of seven consecutive weeks, effective 5 weeks full-time, and can therefore not be combined with other programme components. In exceptional cases, the Board of Examiners may decide to grant a student permission to combine the literature study with other programme components. The Literature Study is completed with a written literature study paper.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lectures series and the entry requirements or additional conditions for admission are published online in the prospectus. In

case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

Electives

The optional part of the programme can consist of additional BPS Lecture series, master's courses of level 400 or higher offered at a Science or Medical Faculty of any Dutch or foreign university, or a traineeship. For courses outside the Faculty of Science of Leiden University approval by the Board of Examiners is required. In exceptional cases, the Board of Examiners may decide to grant an exemption for courses <400 level or for courses of which the level is not explicitly provided. A list of approved elective courses is available in the online module "MSc Bio-Pharmaceutical Sciences" in the learning management system. A student may be awarded credits for acting as an assistant in courses of the Bio-Pharmaceutical Sciences bachelor programme, in proportion to the course load and pending permission from the Board of Examiners, obtaining an ICLON certificate for a didactic skills training, and the completion of a report with a reflection on the provided education. Costs for following elective courses or traineeships are borne fully by the student.

A more comprehensive description of the programme can be found in the prospectus.

4.3. Specialisation BioTherapeutics

4.3.1 Description (Course and Examination Regulations chapter 2)

The MSc specialisation BioTherapeutics offers research-orientated education into the development of new therapeutic approaches to treat immune-based disorders, such as atherosclerosis, metabolic disorders and inflammatory skin diseases. Focus is on state-of-the-art therapies using novel biologicals, such as tolerogenic vaccines, therapeutic proteins and peptides, and gene therapy. The Division BioTherapeutics of the Leiden Academic Centre for Drug Research is involved in the MSc specialisation BioTherapeutics. Admission to this specialisation may be restricted by available places.

Students who complete the specialisation BioTherapeutics are admissible to a PhD programme in bio-pharmaceutical sciences and related science disciplines.

4.3.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Biotherapeutics

- a. have obtained in-depth knowledge of a specific subject related to the development of new therapeutic approaches to treat immune-based disorders, such as atherosclerosis, metabolic disorders and inflammatory skin diseases.
- b. have obtained theoretical and practical skills in a second specialist area of drug research
- c. have deepened and extended learning outcomes 1.3a-d by performing a second research project
- d. are able to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature

4.3.3 Programme (Course and Examination Regulations chapter 3)

The BioTherapeutics (BT) specialisation programme consists of General BPS research components, specialising in BioTherapeutics (55 EC), deepening research specialisation components (43 EC), and compulsory (7 EC) and optional (15 EC) programme components as specified below.

| | Level | EC | Course code |
|-------------------------------------------------------------------------|-------|----|-------------|
| General BPS research components, specialising in BioTherapeutics | | | |
| Introduction Course BPS: BioTherapeutics | 500 | 4 | 4323ICORV |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, in research area of BT | | | |
| • Literature research, practical implementation and | 600 | 44 | 4323RPR44 |
| • Thesis | 600 | 5 | 4323RP1TH |
| • Oral presentation | 500 | 2 | 4323RP1OR |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCO |
| Research specialisation components | | | |
| Research Project 2, in a second area of drug research | | | |
| • Literature research, practical implementation and | 600 | 31 | 4323RP2X9Y |
| • Thesis | 600 | 5 | 4323RP2THY |
| Literature Study, including literature research and literature study | 500 | 7 | 4323LISTTY |
| Electives | | | |
| Optional courses or BPS traineeship | ≥400 | 15 | |

Research Project 1

Research Project 1 must be conducted within the Division BioTherapeutics of the LACDR. Research Project 1 can also take place in the research area of BioTherapeutics at external research groups to which LACDR professors are affiliated or, after approval by the Board of Examiners, at other research groups under the supervision of a staff member of the LACDR.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course "Fish species in animal experimentation" (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

Research Project 2

Research Project 2 may be conducted within the Faculty of Science in another discipline of BPS or in another MSc programme, or at the Center for Human Drug Research, the Leiden University Medical Center, other Science Faculties, University Medical Centers or health research institutes, or at an R&D Department of a (Bio-)Pharmaceutical company. Students are encouraged to go abroad for Research Project 2. All projects outside the LACDR require permission from the Board of Examiners and the Programme Director *before the start* of the project.

Literature Study

The Literature Study must be conducted under supervision of a staff member of LACDR who is from a different Principal Investigator group and has not been affiliated with Research Project 1 or 2. The aim of the literature study is to independently acquire in-depth expert understanding in an unfamiliar drug research subject area by critical review of scientific literature. Therefore, the subject

of the Literature Study must be different from that of Research Project 1 and 2. Otherwise, permission from the Board of Examiners is required. The Literature Study must be carried out within a period of seven consecutive weeks, effective 5 weeks full time, and can therefore not be combined with other programme components. In exceptional cases, the Board of Examiners may decide to grant a student permission to combine the literature study with other programme components. The Literature Study is completed with a written literature study paper.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lectures series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

Electives

The optional part of the programme can consist of additional BPS Lecture series, master's courses of level 400 or higher offered at a Science or Medical Faculty of any Dutch or foreign university, or a traineeship. For courses outside the Faculty of Science of Leiden University approval by the Board of Examiners is required. In exceptional cases, the Board of Examiners may decide to grant an exemption for courses <400 level or for courses of which the level is not explicitly provided. A list of approved elective courses is available in the online module "MSc Bio-Pharmaceutical Sciences" in the learning management system. A student may be awarded credits for acting as an assistant in courses of the Bio-Pharmaceutical Sciences bachelor programme, in proportion to the course load and pending permission from the Board of Examiners, obtaining an ICLON certificate for a didactic skills training, and the completion of a report with a reflection on the provide education. Costs for following elective courses or traineeships are borne fully by the student.

A more comprehensive description of the programme can be found in the prospectus.

4.4. Specialisation Industrial Pharmacy

4.4.1 Description (Course and Examination Regulations chapter 2)

The MSc specialisation Industrial Pharmacy trains students in safety and quality control in the production of medicinal products, and prepares students for a career in Quality Assurance and Quality Control in the biotechnological and pharmaceutical industry.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Industrial Pharmacy are admissible to a PhD programme in bio-pharmaceutical sciences or in related life science disciplines.

4.4.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Industrial Pharmacy have reached the following specific achievement levels:

- a. Industrial pharmaceutical knowledge and understanding of prerequisites for production, quality and safety management, and batch release;
- b. Experience with industrial pharmaceutical quality documentation systems;
- c. Knowledge of industrial pharmaceutical regulatory affairs and ethical issues.

4.4.3 Programme (Course and Examination Regulations chapter 3)

The Industrial Pharmacy (IP) programme consists of general BPS research components (60 EC) and Industrial Pharmacy specialisation components (60 EC) as specified below.

| | Level | EC | Course code |
|-------------------------------------------------------------------------------------------------------|-------|----|-------------|
| General BPS research components | | | |
| Introduction Course BPS in subject of Research Project 1 | 500 | 4 | 4323ICORVY |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, at one of the Divisions of the LACDR | | | |
| • Literature research, practical implementation and | 600 | 42 | 4323RPR42Y |
| • Thesis | 600 | 5 | 4323RP1THY |
| • Oral presentation | 500 | 2 | 4323RP1ORY |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCOY |
| Industrial Pharmacy specialisation components | | | |
| Internship Quality Control /Quality Assurance, including Practical Work, Thesis and Oral Presentation | 600 | 37 | 4323IPINTY |
| Essay Quality Control/Quality Assurance | 600 | 7 | 4323IPEQAY |
| Course Basic Good Manufacturing Practices (GMP) | NA | 2 | 4323QPGM2Y |
| Course Ethics in Quality Control Practices | 500 | 1 | 4323IPEQCY |
| Course Legislation of Production of Medicinal Products | 600 | 1 | 4323IPLP1Y |
| Course Microbial Control in Pharmaceutical Manufacturing | 600 | 4 | 4323MCPHMY |
| Course Quality Management in Pharma and Biotech ⁸ | | | |
| • Quality Management - The role of the Qualified Person | 500 | 2 | 4323QMRQPY |
| • Quality management in drug development | 600 | 2 | 4323QMDRDY |
| • Quality management in sterile manufacturing | 600 | 2 | 4323QMSTMY |
| • Quality Management in Manufacturing of Biopharmaceuticals | 600 | 2 | 4323QMMBPY |

The programme of the specialisation Industrial Pharmacy is under development and may be subject to change.

Research Project 1

Research Project 1 must be conducted within any of the divisions of the LACDR or at the CHDR. Projects can also be conducted within external research groups led by Professors affiliated with a Division of the LACDR, or after permission from the Board of Examiners, by other research groups under supervision of an LACDR staff member.

For research projects involving animal experimentation Introduction to animal experimentation is obligatory. The course “Fish species in animal experimentation” (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

BPS Lecture series

Students choose at least one BPS Lecture series about a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lecture series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

⁸ Pharmaceutical Consultancy Services (PCS) Training BV

Internship Quality Control / Quality Assurance

The internship Quality Control / Quality Assurance must be performed in a biotechnological or pharmaceutical company under supervision of a Qualified Person (QP) and an examiner of the LACDR. The Essay Quality Control / Quality Assurance must have been successfully completed at the same company before the start of the internship.

A more comprehensive description of the programme can be found in the prospectus.

4.5. Specialisation BPS and Business Studies

5.5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Business Studies (BS) offers students the possibility to combine bio-pharmaceutical sciences research training with knowledge, insights, and skills in the area of Management, Business, and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Business Studies are admissible to a PhD programme in bio-pharmaceutical sciences or related science disciplines.

4.5.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Business Studies have reached the following specific achievement levels:

- a. insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses;
- b. the ability to make a plan for a new business or an innovation project;
- c. experience with performing business activities in an existing company or organisation or directed towards technology-based business creation.

4.5.3 Programme (Course and Examination Regulations chapter 3)

The BPS and Business Studies (BS) programme consists of general BPS research components (60 EC), Business Studies specialisation components (20-40 EC), and electives (0-20 EC) as specified below.

| | Level | EC | Course code |
|----------------------------------------------------------|--------------|-----------|--------------------|
| General BPS research components | | | |
| Introduction Course BPS in subject of Research Project 1 | 500 | 4 | 4323ICORVY |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, at one of the Divisions of the LACDR | | | |
| • Literature research, practical implementation and | 600 | 42 | 4323RPR42Y |
| • Thesis | 600 | 5 | 4323RP1THY |
| • Oral presentation | 500 | 2 | 4323RP1ORY |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCOY |
| BS specialisation components | | | |
| BS core courses | 400-500 | 20 | |

| | | |
|---------------|-----|-------|
| BS internship | 600 | 20-40 |
|---------------|-----|-------|

Electives

| | | |
|-------------------------------|---------|------|
| Elective courses in BPS or BS | 400-500 | 0-20 |
|-------------------------------|---------|------|

Research Project 1

Research Project 1 must be conducted within any of the divisions of the LACDR or at the CHDR. Projects can also be conducted within external research groups led by Professors affiliated with a Division of the LACDR, or after permission from the Board of Examiners, by other research groups under supervision of an LACDR staff member.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course “Fish species in animal experimentation” (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lectures series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

BS specialisation components

A minimum of 40 EC and a maximum of 60 EC of BS specialisation components is required to complete the BS specialisation. A specification of the BS specialisation components can be found [here](#).

Electives

The optional part of the programme can consist of additional theoretical courses in the area of bio-pharmaceutical sciences at any Dutch or foreign university, additional BS courses, or a BPS traineeship. The conditions and restrictions specified above for electives apply.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#) and in the prospectus.

4.6. Specialisation BPS and Science Communication and Society

4.6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Science Communication and Society (SCS) offers students the possibility to combine bio-pharmaceutical sciences and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Bio-Pharmaceutical Sciences and Science Communication and Society are admissible to a PhD programme in bio-pharmaceutical sciences or in science communication.

4.6.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Science Communication and Society have reached the following specific achievement levels:

- a. Knowledge and understanding of modern information and communication technology;
- b. Experience in science communication;
- c. Knowledge of ethical, historical and social aspects in the area of the natural sciences.

4.6.3 Programme (Course and Examination Regulations chapter 3)

The BPS and Science Communication and Society (SCS) programme consists of general BPS research components (60 EC), SCS specialisation components (40-60 EC), and electives (0-20 EC) as specified below.

| | Level | EC | Course code |
|----------------------------------------------------------|---------|-------|-------------|
| General BPS research components | | | |
| Introduction Course BPS in subject of Research Project 1 | 500 | 4 | 4323ICORVY |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, at one of the Divisions of the LACDR | | | |
| • Literature research, practical implementation and | 600 | 42 | 4323RPR42Y |
| • Thesis | 600 | 5 | 4323RP1THY |
| • Oral presentation | 500 | 2 | 4323RP1ORY |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCOY |
| SCS specialisation components | | | |
| SCS courses | 400-500 | 23 | |
| SCS project proposal | 600 | 3 | |
| SCS internship(s) | 600 | 14-34 | |
| Electives | | | |
| Elective courses in BPS or SCS or BPS traineeship | 400-500 | 0-20 | |

Research Project 1

Research Project 1 must be conducted within any of the divisions of the LACDR or at the CHDR. Projects can also be conducted within external research groups led by Professors affiliated with a Division of the LACDR, or after permission from the Board of Examiners, by other research groups under supervision of an LACDR staff member.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course "Fish species in animal experimentation" (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS Lecture series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

SCS specialisation components

A specification of the SCS specialisation components can be found [here](#).

Electives

The optional part of the programme can consist of additional theoretical courses in the area of bio-pharmaceutical sciences at any Dutch or foreign university, additional SCS courses, or a BPS traineeship. The conditions and restrictions specified above for electives apply.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#) and in the prospectus.

4.7. Specialisation BPS and Education

4.7.1 Description (Course and Examinations Regulations chapter 2)

The specialisation Bio-Pharmaceutical Sciences and Education (EDU) prepares students for a career as biology (biologie)⁹ or chemistry (scheikunde)¹⁰ teacher qualified to teach in Dutch secondary education (the so-called “eerstegraads-lesbevoegdheid”, qualifying the student to teach in Dutch upper secondary education).

Students who complete the specialisation Bio-Pharmaceutical Sciences and Education are admissible to a PhD programme in bio-pharmaceutical sciences or related science disciplines.

4.7.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme BPS with the specialisation Education have reached the following specific achievement levels:

- a. All qualifications necessary for teaching all years of secondary education and technical and vocational training (for 12–18 year-olds).

4.7.3 Programme (Course and Examination Regulations chapter 3)

The BPS and Education (EDU) programme consists of general BPS research components (60 EC) and EDU specialisation components (60 EC) as specified below.

| | Level | EC | Course code |
|----------------------------------------------------------|---------|----|-------------|
| General BPS research components | | | |
| Introduction Course BPS in subject of Research Project 1 | 500 | 4 | 4323ICORVY |
| BPS Lecture series | 500 | 4 | |
| Research Project 1, at one of the Divisions of the LACDR | | | |
| • Literature research, practical implementation and | 600 | 42 | 4323RPR42Y |
| • Thesis | 600 | 5 | 4323RP1THY |
| • Oral presentation | 500 | 2 | 4323RP1ORY |
| Advanced Academic Skills and Career Orientation | 500 | 3 | 4323AASCOY |
| EDU specialisation components | | | |
| EDU courses | 400-500 | 30 | |
| EDU internship(s) | 600 | 30 | |

⁹ BPS Master’s Students wishing to qualify for the school subject “Biology”, need to remedy their deficiencies in concert with the teacher educator Biology of the ICLON.

¹⁰ BPS Master’s students wishing to qualify for the school subject “Chemistry”, need to remedy the deficiencies in concert with the teacher educator Chemistry of the ICLON.

Electives

Elective courses or BPS traineeship

400-600

0-30

Research Project 1

Research Project 1 must be conducted within any of the divisions of the LACDR or at the CHDR. Projects can also be conducted within external research groups led by Professors affiliated with a Division of the LACDR, or after permission from the Board of Examiners, by other research groups under supervision of an LACDR staff member.

For research projects involving animal experimentation the Introduction to animal experimentation is obligatory. The course "Fish species in animal experimentation" (2 EC, level 400) is required for research projects that involve experimental use of fish species. Lab safety is mandatory for all students.

BPS Lecture series

Students choose at least one BPS Lecture series from a broad range of topics that provide an up-to-date overview of recent developments in a specific area of drug research. BPS lectures series and the entry requirements or additional conditions for admission are published online in the prospectus. In case the number of participants of the Lecture series is limited, the maximum number of participants and the placement procedure will also be announced in the prospectus.

EDU specialisation components

In general 60 EC of EDU specialisation components are required to complete the EDU specialisation. If the minor EDU was successfully completed as part of the BSc programme the EDU specialisation component is limited to 30 EC. A specification of the EDU specialisation components can be found [here](#). Research Project 1 must have been successfully completed before students will be allowed to start with the EDU specialisation components.

Electives

The optional part of the programme can consist of additional theoretical courses in the area of biopharmaceutical sciences at any Dutch or foreign university or a BPS traineeship. The conditions and restrictions specified above for electives apply.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#) and in the prospectus.

MSc Biology

CROHO-number 66860

1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc Biology programme builds on the unique combination of biological institutes in Leiden joining forces: the Institute of Biology Leiden (IBL), the Institute of Environmental Sciences (CML), and the Naturalis Biodiversity Center (Naturalis). The choice of courses and research projects is further increased by the embedding in the Faculty of Science and the connections with the Leiden University Medical Center (LUMC), the Netherlands Institute of Ecology (NIOO, Wageningen) and with bioscience-based companies that are also located at the Leiden Bioscience Park.

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Biology (MSc in Biology) with specification of the specialisation, if applicable. The degree provides graduates with the academic training and research skills required to pursue a scientific or science-related career. All specialisations have the same Director of Education, Education Committee and Board of Examiners. A Board of Admissions advises on admissions.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

Students can follow a *General Biology (GR)* programme or choose one of the research specialisations: *Biodiversity and Sustainability (BS)*, *Evolutionary Biology (EB)*, *From Cells to Organisms (FCTO)*, *Molecular Genetics and Biotechnology (MGB)*. In addition, a programme can be taken that combines biology with training in either *Business Studies (BS)*, *Education (EDU)* or *Science Communication and Society (SCS)*. Below you can find a description of the Biology research specialisations and of the “Biology part” of the vocational specialisation (BS, EDU, SCS). A description of the non-Biology part of these specialisations can be found in a separate appendix of the OER.

1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February. However, they are strongly encouraged to start in September when a general introduction to the master programme and most of the compulsory theoretical courses are scheduled.

1.4 The objective of the master's programme in Biology

To impart sufficient knowledge, understanding and skills as to enable the graduate to contribute independently, at an academic level and in an original manner to recognizing, coming up with and solving issues in an area of the natural sciences, to discuss this contribution with colleagues, to inform non-specialists in a clear and unambiguous manner on conclusions and considerations that form the foundation of the study. The programme prepares students to successfully follow a PhD programme within the discipline and its marginal areas and to start a career in research positions at universities or research institutes or to start a career in (bio-based) industry, governmental organisations, consultancy agencies or as a biology teacher or to start a career in popularisation of science or as a scientist with a communicating mind-set.

1.5 Final qualifications of the master's programme

Each variant within the Master's programme has the same final level when it comes to general academic qualifications. All variants also give access to the promotion. However, they differ from each other due to a number of specific final objectives and competences.

Final objectives

The Master of Science in Biology - research specialisation:

1. Has knowledge of and insight into the basic subjects of biology.
2. Has an extensive knowledge of concepts and working methods in an important sub-area of biology and insight into the way in which they have been created and can be applied to increase knowledge.
3. Is aware of the most important international scientific developments in the mentioned field.
4. Has insight into the relationship between the aforementioned field and adjacent scientific fields.
5. Demonstrated his/her ability to independently analyze scientific problems and formulate verifiable hypotheses that could lead to the solution of such problems.
6. Has experience in setting up and conducting scientifically relevant research on the basis of an independently formulated research plan, based on a thorough analysis of relevant professional literature.
7. Has shown that she/he can present her/his own research results clearly in writing and orally.
8. Demonstrated skill in summary and critical reflection on scientific literature.
9. Has insight into the social and ethical discussions surrounding his/her field.
10. Has a good idea of the professional opportunities and practice in the field of specialization.

With due observance of a shorter research program (at least 60 EC), the following final objectives apply to the master variants "Biology and Business Studies", "Biology and Science Communication and Society" and "Biology and Education":

Business Studies variant:

11. Has basic knowledge of and insight in strategic and marketing management, financial management, project management, organizational science, patents and quality management.
12. Has experience in setting up and conducting organizational research within a company, in connection with the research specialization.

Science Communication and Society variant:

11. Has knowledge of and skills in science communication theory and methods and is able to apply it;
12. Has gained experience with science communication practice;
13. Has knowledge of ethical, historical and social aspects in the area of the natural sciences.

Education variant:

11. Meets all conditions for obtaining the power to teach all classes of secondary and secondary vocational education.
12. Has developed an educational vision taking into account the relationship between school and society and with respect for the standards accepted in our plural society values.

Competences

The Master of Science in Biology:

1. Masters the knowledge and skills that can be expected nationally and internationally from a junior researcher in the field of specialization.
2. Is able to contribute to knowledge increase in the field by means of original (fundamental or application-oriented) research based on knowledge and insight in the field and problem solving ability.
3. Is able to write a scientific article for an international journal and contribute to a scientific meeting by means of a lecture or poster.
4. Is able to transfer oral and written knowledge in his/her own field to specialists and non-specialists and to contribute to scientific and social discussions in the field.
5. Is able to function in a (mono or multidisciplinary composed) scientific team and can contribute from her/his own specialization to the realization of the objectives of the team.
6. Is able to critically evaluate own and other people's research results.
7. Is able to involve social and ethical aspects and responsibilities in the assessment of research and professional practice.

In principle, the same competences apply to the master variants Business Studies, Science Communication and Society, and Education, with a number of adjustments and taking into account the shorter research programme.

Business Studies variant:

8. Is able to apply organizational and business principles in general and in particular in the social use of results of research in biology.
9. Is capable of innovation and entrepreneurship from the perspective of biology.

Science Communication and Society variant:

8. Has insight in science communication and is able to further develop as a journalist, information officer or communication officer at a university, in a museum, in business, or in the government.

Education variant:

8. Can function as a subject teacher and as a supervisor of learning processes.
9. Is willing and able to actively participate in organizational activities at the school level.
10. Is willing and able to carry out a practice-oriented educational or didactic research individually or in a team.

2. Admission to the programme (Course and Examination Regulations chapter 5)

2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 5.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.¹¹

2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Biology from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a biology-related programme from a research university in the Netherlands or from a foreign research university, under the provisions mentioned below and after assessment of the application by the Board of Admissions.. For admission to any of the research-based specialisations of this master this under the provision that the bachelor's programme has provided the candidate with:

In depth knowledge and skills obtained through undergraduate courses of Biology (referred to under a.) including:

- molecular and cell biology,
- evolutionary biology and ecology,
- developmental biology,
- biodiversity
- mathematics and statistics.

Biology related programmes include e.g. natural sciences, life science, biomedical sciences, bio-pharmaceutical sciences, biotechnology and bioinformatics, environmental sciences, agricultural sciences, etc., all at the discretion of the Board of Admissions

- c. Holders of a bachelor's degree and additionally having passed the prescribed pre-master's programme pursuant to Article 2.4.1

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a research university or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in biology-related programmes.

(As a guideline) for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained at least within a maximum of five years and with an average final grade of at least 7.5 and a research internship grade of 8 or higher.

Admission process

Applicants as referred to in Article 2.2.1. b and Article 2.2.2. are requested to provide the Board of Admissions with:

¹¹[Regulations for Admission to Master's Programmes](#)

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1 a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1 a.

2.2.3 Dutch and English languages¹²

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

2.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Gevorderd.

2.2.4 Qualitative admission requirements

Not applicable.

¹² Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (x may vary from 1 to 15) EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

2.4 Bridging programmes (Pre-master's)

2.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- For students with bachelor's degrees related to Biology the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

2.4.2 Information on the bridging programmes can be requested from the department. For more information contact the Education Office via biomscstudieadviseur@biology.leidenuniv.nl

3. Entry requirements for courses, examinations and practicals

3.1 Students are expected to purchase the required reading for a given course, as set out in the course description in the prospectus and/or on Brightspace. A student who is not in possession of the required literature may be excluded from participating in the course in question.

3.2 The entry requirements or additional conditions for participating in specific elective courses can be found in the appendix to the OER (the degree programme) and/or the prospectus.

3.3 For all components of the Master programme, the lecturer may decide to make lecture attendance compulsory.

3.4 The costs of following elective courses are borne fully by the student.

3.5 The scope for electives in the Master's programme may not comprise more than 15 EC of courses that do not contain any biological component.

4. Specialisation Biodiversity and Sustainability

4.1 Description (Course and Examination Regulations chapter 2)

This research-oriented master specialisation offers students in-depth knowledge on relationships between biodiversity and society. The critical importance of biodiversity and the services provided by nature for our society is increasingly endorsed by national and international conventions. However, to implement the right policy measures for creating a sustainable society, a much better understanding of the biological processes involved is essential. This master specialisation aims to discuss and answer societal relevant biological questions for instance on the amount of biodiversity we need to ensure that nature functions well and how we can optimize ecosystem functioning and biodiversity for a sustainable society. By using 'sustainability' as a guiding principle, the programme provides students with an academic attitude by stimulating reflective, independent and creative thinking to support, conserve and manage biodiversity and sustainable ecosystem services. This master specialisation prepares students for a PhD programme and/or for research positions at universities or research institutes and for positions at governmental organisations and consultancy agencies.

4.2 Programme (Course and Examination Regulations chapter 3)

The programme of Biodiversity and Sustainability (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components and can be expanded with a wide choice of elective elements. The mandatory components in the 1st semester aim to provide students with the theoretical and practical background needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A "Fish specific animal experimentation course (2 EC) or a "Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

| <i>Compulsory:</i> | Level | EC |
|-----------------------------------------------------------|--------------|-----------|
| Orientation on Biodiversity and Sustainability 4313OBS17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| Human Impacts on Biodiversity 4313HIB16Y | 500 | 6 |
| Systematics and Biodiversity 4313SYB20Y | 500 | 6 |

At least one of the following courses:

| | | |
|-------------------------------------------------------------------|-----|------------|
| • Ecosystem Services 4313ECS16Y | 500 | 6 |
| • Ecotoxicology | 500 | 6 |
| Research Project(s) (at least 36 EC within the specialisation) | 600 | min. 60 |
| Electives | | max. 30 |
| Total Programme | | 120 |

Electives/Optional elements

The optional part of the programme can consist of either additional courses, or an extension of the duration of a research project. A list of approved elective courses is available in the prospectus. For courses outside the Leiden University Biology programme, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

4.3 Approval of programme

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

4.4 Short description of the courses

Courses cover a broad range of relevant subjects and provide in-depth theoretical knowledge as well as training in practical skills and advanced research tools. The course *Orientation on Biodiversity and Sustainability* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation.

The course “*Genomic Architecture*” aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes as tools for biomonitoring, and an introduction into bio-informatics. The interface between biodiversity and sustainability is taught in ‘*Ecosystem Services*’ and ‘*Human Impacts on Biodiversity*’. In addition, students are trained in ‘*Advanced Statistics*’ and ‘*Systematics and Biodiversity*’, providing the methodological tools for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the e-Prospectus and Brightspace.

5. Specialisation Evolutionary Biology

5.1 Description (Course and Examination Regulations chapter 2)

This research-oriented master specialisation provides students with in-depth knowledge about Evolutionary Sciences. Students learn about evolutionary changes over time and study the origin and maintenance of biological variation all over the tree of life. The mechanisms that drive the adaptation of organisms and their features are investigated at all biological levels. Thus, the specialisation includes genomics, functional developmental genetics, paleobiology, behavioural biology and evolutionary ecology. With this master specialisation completed, the students are well

equipped to start a career in evolutionary research or to take the responsibility for projects in an industrial or institutional research environment.

5.2 Programme (Course and Examination Regulations chapter 3)

The programme of Evolutionary Biology (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components and can be expanded with a wide choice of elective elements. The mandatory components in the 1st semester aim to provide students with the theoretical and practical background needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

| <i>Compulsory:</i> | Level | EC |
|-------------------------------------------------------------------|--------------|------------|
| Orientation on Evolutionary Biology 4313OEV17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| Development & Evolution 4313DEV13Y | 500 | 6 |
| Systematics and Biodiversity 4313SYB20Y | 500 | 6 |
| Research Project(s) (at least 36 EC within the specialisation) | 600 | min. 60 |
| Electives | | max. 30 |
| Total Programme | | 120 |

Electives/Optional elements:

The optional part of the programme can consist of either additional courses or lectures, or an extension of the duration of a research project. A list of approved elective courses is available on the prospectus. For courses outside the Leiden University Biology programme and for all research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

5.3 Approval of programme

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

5.4 Short description of the courses

The Evolutionary Biology study programme comprises several compulsory courses. The course *Orientation on Evolutionary Biology* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course *Genomic Architecture* aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the *Advanced Statistics* course, and one of the specialisation courses this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the prospectus and Brightspace.

6. Specialisation From Cells to Organisms

Note: as of 2022-2023 this specialisation will be called Molecular, Cellular and Organismal Biology

6.1 Description (Course and Examination Regulations chapter 2)

This research-oriented master specialisation offers students the unique possibility to integrate molecular, cellular and organismal levels of research, but also provides the possibility to specialize in one of these levels. It equips students with advanced knowledge ranging from the functioning of individual cells to the communication between cells, and the development, physiology and behaviour of multicellular organisms. An important aspect of this specialisation is to understand the molecular mechanisms underlying health and disease and how cells and organisms adapt to environmental factors ranging from light, stress and pathogens to ecological and social conditions. Model organisms include bacteria, fungi, plants and animals (invertebrates and vertebrates). The subject areas covered encompass functional genomics, signal transduction, cellular differentiation, development, host-microbe interactions and animal behaviour.

This master specialisation is suited as a basis for starting a research career at a university or research institute and for a position in a bioscience-based company.

6.2 Programme (Course and Examination Regulations chapter 3)

The programme of the specialisation From Cells to Organisms (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components and can be expanded with a wide choice of elective elements. The mandatory components in the 1st semester aim to provide students with the theoretical and practical background needed for an efficient start of the Research Project at the end

of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

| <i>Compulsory:</i> | Level | EC |
|-------------------------------------------------------------------|--------------|------------|
| Orientation on From Cells to Organisms 4313OFC17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| <i>At least two of the following courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Animal Personality 4313ANP17Y | 500 | 6 |
| • Animal Cognition 4313ANC15Y | 500 | 6 |
| • Development and Evolution 4313DEV13Y | 500 | 6 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |
| Research Project(s) (at least 36 EC within the specialisation) | 600 | min. 60 |
| Electives | | max. 30 |
| Total Programme | | 120 |

Electives/Optional elements

The optional part of the programme can consist of either additional courses or lectures, or an extension of the duration of a research project. A list of approved elective courses is available on the prospectus. For courses outside the Leiden University Biology programme and for all research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

6.3 Approval of programme

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

6.4 Short description of the Courses

The From Cells to Organisms study programme comprises several compulsory courses. The course *Orientation on From Cells to Organisms* provides a state of the art overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course *Genomic Architecture* aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the *Advanced Statistics* course, and two specialisation courses this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the prospectus and Brightspace.

7. General Biology Programme

(no research specialisation)

7.1 Programme (Course and Examination Regulations chapter 3)

The General Biology programme (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components, and can be expanded with a wide choice of elective elements. The mandatory components in the 1st semester aim to provide students with the theoretical and practical background needed for an efficient start of the specialisation Research Project at the end of this semester.

All Research Projects require prior approval by the Board of Examiners through approval of the individual study plan of a student and approval of the research agreement.

Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. Each Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

| | Level | EC |
|---------------------------------------------------------------------|-------|----|
| <i>One of the courses:</i> | | |
| • Orientation on Biodiversity and Sustainability 4313OBS17Y | 400 | 2 |
| • Orientation on Evolutionary Biology 4313OEV17Y | 400 | 2 |
| • Orientation on From Cells to Organisms 4313OFC17Y | 400 | 2 |
| • Orientation on Molecular Genetics and Biotechnology 4313OMG17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |

| | | |
|---------------------------------------------------------------|-----|------------|
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| <i>At least 18 EC of the courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Advanced Molecular Genetics and Biotechnology 4313AMG17Y | 500 | 3 |
| • Animal Personality 4313ANP17Y | 500 | 6 |
| • Animal Cognition 4313ANC15Y | 500 | 6 |
| • Paleobiology 4313PAB17Y | 500 | 3 |
| • Development and Evolution 4313DEV13Y | 500 | 6 |
| • Ecosystem Services 4313ECS16Y | 500 | 6 |
| • Ecotoxicology 4313ETX19Y | | |
| • Human impacts on biodiversity 4313HIB16Y | 500 | 6 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Systematics and Biodiversity 4313SYB20Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |
| | 500 | 6 |
| • <i>Or courses from the list of approved electives</i> | | |
| Research Project(s) | 600 | min. 60 |
| Electives | | max. 30 |
| Total Programme | | 120 |

Electives/Optional elements

The optional part of the programme can consist of either additional courses or lectures, or an extension of the duration of a research project. A list of approved elective courses is available on the prospectus. For courses outside the LU Biology programme and for all research projects, prior approval of the Board of Examiners is required.

Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

7.2 Approval of programme

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

7.3 Short description of the Courses

Courses cover a broad range of relevant subjects and provide in-depth theoretical knowledge as well as training in practical skills and advanced research tools. The Orientation courses provide a state of the art overview of the scientific research and research methods of the participating Institutes.

The course *Genomic Architecture* aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. In addition, students are trained in *Advanced Statistics* and follow at least one specialised course providing students with an integrated picture on specific topics for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the Prospectus and Brightspace.

8. Specialisation Molecular Genetics and Biotechnology

8.1 Description (Course and Examination Regulations chapter 2)

The master specialisation *Molecular Genetics and Biotechnology* focusses on genetics, molecular biology, genomics and biotechnology of animal, plant and microbial systems. Through courses and research projects, students are trained by experts in the areas of molecular biology, microbiology, plant genetics, cellular imaging, animal disease models, and various –omics technologies and the corresponding bioinformatics. Attention is paid to the application of these techniques to biotechnology, i.e. how studies on model organisms can be translated to improve crops or human health. Students graduating in this master specialisation are well trained to start a research career in biological and medical sciences or lead projects in industrial or institutional research environments.

This master specialisation is suited as a basis for starting a research career at a university or research institute and for a position in a bioscience-based company.

8.2 Programme (Course and Examination Regulations chapter 3)

The programme of *Molecular Genetics and Biotechnology* (120 EC) consists of:

- a theoretical part (30-60 EC); and
- one or more research projects (60-90 EC).

The programme includes some compulsory components and can be expanded with a wide choice of elective elements. The mandatory components in the 1st semester aim to provide students with the theoretical and practical background needed for an efficient start of the Research Project at the end of this semester. The Research Projects are the actual core of the MSc programme. Students will be member of a research group of their choice and work full time on a specific project. Each project will be finished with an MSc thesis written in the form of a manuscript for an international scientific journal. At least one but preferably two Research Projects are part of the study programme.

The Specialisation Research Project has to be done within the theme of the specialisation. Prior to the start of the Research Project, the Board of Examiners has to approve the individual study plan of the student and the Research Project agreement.

Compulsory components:

Each MSc-programme consists for at least 30 EC of theoretical components and the Research project(s) contribute at least 60 EC. The specialisation Research Project should be minimally 36 EC, and a second Research Project should be at least 30 EC. A single research project cannot exceed 60 EC. A “Fish specific animal experimentation course” (2 EC) or a “Bird specific animal experimentation course” (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

| <i>Compulsory:</i> | Level | EC |
|----------------------------------------------------------------|--------------|-----------|
| Orientation on Molecular Genetics and Biotechnology 4313OMG17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| Advanced Molecular Genetics and Biotechnology 4313AMG17Y | 500 | 3 |
| <i>At least one of the following courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |

| | | |
|-------------------------------------------------------------------|-----|------------|
| Research Project(s) (at least 36 EC within the specialisation) | 600 | min. 60 |
| Electives | | max. 30 |
| Total Programme | | 120 |

Electives

Electives can consist of either additional courses or lectures, or an extension of the duration of a research project. A list of approved elective courses is available on the prospectus. For courses outside the LU Biology programme and for all research projects, prior approval of the Board of Examiners is required. Note: No more than 12 EC of optional theoretical elements of level < 400 are permitted and at most 15 EC of non-biology courses.

8.3 Approval of programme

The individual study programme consisting of choices of courses and one or two research projects must have prior approval of the Board of Examiners.

8.4 Short description of the courses

The Molecular Genetics and Biotechnology study programme comprises several compulsory courses. The course *Orientation on Molecular Genetics and Biotechnology* provides an overview of the scientific research and research methods used in the departments participating in this MSc specialisation. The course *Genomic Architecture* aims at training students to become “genome-enabled” biologists by giving an overview of the structure, function and evolution of genomes, and an introduction into the bio-informatics required to study these genomes. Together with the *Advanced Statistics* course, and the specialisation courses, this will prepare the students theoretically for their training in scientific research during the Research Project(s).

A variety of additional courses from other MSc specialisations in Biology and from other MSc programmes at the Faculty of Science and LUMC can be chosen as electives. For details (description, literature, exam dates and further calendar events) about the different courses see the Prospectus and Brightspace.

9. Specialisation Business Studies

9.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Business Studies offers students the possibility to combine biology with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Biology and Business Studies are admissible to a PhD programme.

9.2 Programme (Course and Examination Regulations chapter 3)

The Biology and Business Studies programme consists of:

- 24 EC of advanced theory;

- a research project of 36 EC;
- 40-60 EC Business studies component, as described [here](#).
- a maximum of 20 EC of electives within either Biology or the Business Studies component;
and

The theoretical part of the Biology research component comprises:

| | Level | EC |
|---------------------------------------------------------------------|--------------|------------|
| <i>One of the courses:</i> | | |
| • Orientation on Biodiversity and Sustainability 4313OBS17Y | 400 | 2 |
| • Orientation on Evolutionary Biology 4313OEV17Y | 400 | 2 |
| • Orientation on From Cells to Organisms 4313OFC17Y | 400 | 2 |
| • Orientation on Molecular Genetics and Biotechnology 4313OMG17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| <i>At least 12 EC of the courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Advanced Molecular Genetics and Biotechnology 4313AMG17Y | 500 | 3 |
| • Animal Cognition 4313ANC15Y | 500 | 6 |
| • Animal Personality 4313ANP17Y | 500 | 6 |
| • Paleobiology 4313PAB17Y | 500 | 3 |
| • Development and Evolution 4313DEV13Y | 500 | 6 |
| • Ecosystem Services 4313ECS16Y | 500 | 6 |
| • Ecotoxicology 4313ETX19Y | 500 | 6 |
| • Human impacts on biodiversity 4313HIB16Y | 500 | 6 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Systematics and Biodiversity 4313SYB20Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |
| • <i>Or courses from the list of approved electives</i> | | |
| Total Programme | | 120 |

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project that involves handling or experimental use of fish species or birds species.

The Biology component can be extended with an additional 20 EC (courses or extension of the research project)).

Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners through approval of the individual study plan of a student and approval of the research agreement.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

10. Specialisation Education

10.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Education (EDU) prepares students for a career as biology (biologie) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Biology and Education are admissible to a PhD programme.

10.2 Programme (Course and Examination Regulations chapter 3)

The Biology and Education (EDU) programme consists of:

- 24 EC of advanced theory;
- a research project of 36 EC;
- 60 EC Education component as described [here](#).

The theoretical part of the Biology research component comprises:

| | Level | EC |
|---------------------------------------------------------------------|-------|----|
| <i>One of the courses:</i> | | |
| • Orientation on Biodiversity and Sustainability 4313OBS17Y | 400 | 2 |
| • Orientation on Evolutionary Biology 4313OEV17Y | 400 | 2 |
| • Orientation on From Cells to Organisms 4313OFC17Y | 400 | 2 |
| • Orientation on Molecular Genetics and Biotechnology 4313OMG17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| <i>At least 12 EC of the courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Advanced Molecular Genetics and Biotechnology 4313AMG17Y | 500 | 3 |
| • Animal Cognition 4313ANC15Y | 500 | 6 |
| • Animal Personality 4313ANP17Y | 500 | 6 |
| • Paleobiology 4313PAB17Y | 500 | 3 |
| • Development and Evolution 4313DEV13Y | 500 | 6 |
| • Ecosystem Services 4313ECS16Y | 500 | 6 |
| • Ecotoxicology 4313ETX19Y | 500 | 6 |
| • Human impacts on biodiversity 4313HIB16Y | 500 | 6 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Systematics and Biodiversity 4313SYB20Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |
| • <i>Or courses from the list of approved electives</i> | | |

Total Programme

120

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project in which experiments with fish or birds are involved.

The research project has to take place in one of the research groups of the IBL, CML or Naturalis, other Institutes of the Faculty of Sciences or LUMC.

Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners through approval of the individual study plan of a student and approval of the research agreement. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

11. Specialisation Science Communication and Society

11.1 Description (Course and Examination Regulations chapter 2)

The specialisation Biology and Science Communication and Society (SCS) offers students the possibility to combine physics and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Biology Sciences and Science Communication and Society are admissible to a PhD programme in biology or in science communication.

11.2 Programme (Course and Examination Regulations chapter 3)

The Biology Science Communication and Society (SCS) programme consists of:

- 24 EC of advanced Biology theory;
- a Biology research project of 36 EC;
- 40-60 EC Science Communication & Society component. The science component consists of the parts specified as follows:

| | Level | EC | Catalog nr |
|----------------------------------------------|---------|-------|------------|
| Informal Science Education* | 400 | 4 | 4603SCISEY |
| Policy & Development in science and Society* | 400 | 4 | 4603SCPDSY |
| Research in science communication* | 400 | 4 | 4603SCRSCY |
| Science Journalism (ENG)* | 400 | 4 | 4603SCSJ4Y |
| Wetenschapsjournalistiek (NL)* | 400 | 4 | 4603SCSWJY |
| Science Communication product development** | 400 | 4 | 4603SCPRDY |
| SCS: Scientific Narration and Visualization* | 500 | 3 | 4603SCNV3Y |
| Internship | | | |
| SCS Project Proposal | 600 | 3 | 4603SCSPPY |
| SCS Internship(s) | 600 | 14-34 | 4603SCSS1Y |
| Additional elective | | | |
| SCS elective | 400-500 | 1-okt | 4603SCSELY |

* SCS courses are available as elective course for students who don't follow the SCS specialisation.

** the course **Science Communication product development** is only admissible for students who have completed all other SCS courses.

- a maximum of 20 EC of electives within either Biology or the SCS component

The theoretical part of the Biology research component comprises:

| | Level | EC |
|---------------------|-------|----|
| One of the courses: | | |

| | | |
|---------------------------------------------------------------------|-----|---|
| • Orientation on Biodiversity and Sustainability 4313OBS17Y | 400 | 2 |
| • Orientation on Evolutionary Biology 4313OEV17Y | 400 | 2 |
| • Orientation on From Cells to Organisms 4313OFC17Y | 400 | 2 |
| • Orientation on Molecular Genetics and Biotechnology 4313OMG17Y | 400 | 2 |
| Advanced Statistics 4313AST17Y | 500 | 4 |
| Genomic Architecture 4313GEA13Y | 400 | 6 |
| <i>At least 12 EC of the courses:</i> | | |
| • Advanced Cell Biology 4313ACB17Y | 500 | 4 |
| • Advanced Molecular Genetics and Biotechnology 4313AMG17Y | 500 | 3 |
| • Animal Cognition 4313ANC15Y | 500 | 6 |
| • Animal Personality 4313ANP17Y | 500 | 6 |
| • Paleobiology 4313PAB17Y | 500 | 3 |
| • Development and Evolution 4313DEV13Y | 500 | 6 |
| • Ecosystem Services 4313ECS16Y | 500 | 6 |
| • Ecotoxicology 4313ETX19Y | 500 | 6 |
| • Human impacts on biodiversity 4313HIB16Y | 500 | 6 |
| • Innate Immune Systems 4313IIS18Y | 500 | 6 |
| • Systematics and Biodiversity 4313SYB20Y | 500 | 6 |
| • Mechanisms of Disease 4313MOD13Y | 500 | 6 |
| • <i>Or courses from the list of approved electives</i> | | |

Total Programme

120

A “Fish specific animal experimentation course (2 EC) or a “Bird specific animal experimentation course (2 EC) is obligatory in case of a research project in which experiments with fish or birds are involved.

The Biology component can be extended with an additional 20 EC (courses or extension of the research project).

Theoretical components should be minimally at level 400. The individual study programme consisting of choices of courses and the research project must have prior approval by the Board of Examiners through approval of the individual study plan of a student and approval of the research agreement.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

MSc Chemistry

CROHO-number 66857

1. Description of the programme (Course and Examination Regulations chapter 2)

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The LIC offers two MSc programmes, namely the MSc Chemistry and the MSc Life Science and Technology. Chemistry research in the LIC is centred on the two research areas *Chemical Biology* and *Energy & Sustainability*, which are leading for the courses and research training projects offered in the MSc programme Chemistry.

Chemical Biology research at the Leiden Institute of Chemistry is aimed at understanding biological processes at the molecular level to strengthen the knowledge base of human health and disease. The approach to achieve this goal is a fundamental chemical one; biological systems are interrogated with the aid of chemical probes. Our chemical biology research is conducted in the context of health and disease, and aims to acquire knowledge, tools and techniques for the design and development of human medicine. The ultimate goal is to contribute to human health through conceptually new chemical methods for diagnosis, drug development and new therapies for diseases.

The **Energy & Sustainability** research is focused on a fundamental level on chemical reactions that are of importance to the sustainable and efficient production and storage of energy, as well as the subsequent usage of stored energy. The researchers apply advanced spectroscopic techniques, nano-imaging, inorganic synthesis, homogeneous, heterogeneous, photochemical or electrochemical catalysis and theoretical methods to elucidate the molecular processes that are at the basis of the conversion of solar energy to chemical energy.

Detailed information concerning the research topics that are investigated at the LIC can be found on the websites of the research groups, via <https://www.universiteitleiden.nl/en/science/chemistry/>.

1.1 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme Chemistry offers four specialisations, each with a focus on one of these two major research areas. The four specialisations are: Research in Chemistry (CHEM), Chemistry and Business Studies (BS), Chemistry and Science Communication and Society (SCS) and Chemistry and Education (EDU). The duration of each specialisation is two years (120 EC); a general overview of the content of the four specialisations is given in Table 1. Students who complete the programme receive the degree Master of Science in Chemistry, with specification of the specialisation.

Table 1: Overview of the programmes of the four MSc Chemistry specialisations (weights in EC)

| Specialisation | CHEM | EDU [#] | SCS | BS |
|-------------------------------|------------|------------------|------------|------------|
| Research training | 60 | 30 / 40 | 30 | 30 |
| Academic Skills | 6 | 6 | 6 | 6 |
| Core courses in research area | 24 | 24* | 24 | 24 |
| Essay & Colloquium | 6 | - | - | - |
| Free electives** | 24 | 0 / 20 | 20 | 20 |
| EDU/SCS/BS components | - | 60 / 30 | 40 | 40 |
| Total EC | 120 | 120 | 120 | 120 |

* Students in the EDU specialisation are allowed and advised to choose from both research areas to obtain a broader knowledge of chemistry.

** The choice in the free electives is restricted to the boundaries specified in this document. A maximum of 20 EC can be used for extension of the research training. A maximum of 20 EC may be used as an extension of the SCS or BS components.

If the student has taken a minor in Education ("tweedegraadsbevoegdheid") of 30 EC in the BSc programme, only 30 EC are necessary in the MSc programme to obtain the "eerstegraadsbevoegdheid"; then 30 EC electives are added to the programme of the MSc Chemistry, of which at least 10 EC should be used for research training within the boundaries specified in sections 4.3 and 7.3.

1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

After completion of the MSc Chemistry programme students will have developed:

- Knowledge and understanding of theoretical concepts of Chemistry from textbooks and primary literature pertaining to the research area "Chemical Biology" or "Energy & Sustainability"
- The ability to plan chemical research, perform experiments within an appropriate time frame, collect and store data in a logical way, such that colleagues can easily find and access the data (data management)
- The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, and formulate verifiable hypotheses
- An appropriate critical scientific attitude, i.e. the ability to analyse results and critically evaluate their validity and accuracy
- The skill to communicate chemical research progress and results to colleagues, supervisors and experts
- The ability to write independently a structured and accurate report on performed chemical research
- The ability to perform with an academic attitude and the skills for autonomous self-development, taking into account the ethical and social aspects of the natural sciences.

1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February; international students are strongly advised to start in September.

1.4 Programme organisation

All specialisations have the same Programme Director and the same Board of Admissions. The Programme Committee for the MSc programme Chemistry is combined with the one for the MSc programme Life Science and Technology and is responsible for the Research specialisation and the programme-specific components of the other specialisations. The specialisation-specific components of the BS, EDU and SCS specialisations have their own Programme Committees. The Board of Examiners of the MSc programme Chemistry is also combined with the one of the MSc programme Life Science and Technology. In addition, the specialisations BS, SCS and EDU each have their own faculty-wide Board of Examiners appointed by the Faculty of Science for the specialisation-specific part of the MSc Chemistry programme.

All MSc students are guided by a personal mentor. The mentor generally is the supervisor of the major research training project in the research area chosen by the student. The mentor will coach the student from the admission throughout the MSc programme to the final examination. The study adviser can advise the student concerning scheduling and planning of the programme. A web-based master planner is used for planning and registration of the study programme, and is to be filled in by

the student in consult with the mentor. The mentor and student discuss the progress of the student at least every six months using the results documented in the master planner. The master planner is updated by the student on a regular basis. It is accessible to the student, the mentor, the study coordinator and the study adviser. The study adviser will mediate when a student encounters problems in the interaction with the mentor.

2. Programme (Course and Examination Regulations chapter 3)

Students compose their own study programme (choice in core courses, electives and research training project) in consent with their mentor, who is a scientific staff member of the LIC. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate. The programme may be adjusted during the course of the MSc study.

Specialisation-specific components of the specialisations Chemistry and Business Studies, Chemistry and Science Communication and Society, and Chemistry and Education are described separately in this Appendix. A double specialisation comprises a full programme of one specialisation (i.e. the main specialisation) plus the specialisation-specific components of a second specialisation. The main specialisation should be chosen in the following order: Research above Education above Business/Communication. The number of credits for double specialisations thus must be at least 150 EC (Research + EDU-30), 160 EC (Research + BS; Research + SCS; EDU + BS, EDU + SCS, BS + SCS) or 180 EC (Research + EDU-60).

3. Admission to the programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.¹³

3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Molecular Science and Technology (MST) from any research university in the Netherlands, or
- b) holders of a bachelor's degree in an MST- or chemistry-related programme from a research university in the Netherlands or from a foreign research university of equal level, provided that the candidate has:

¹³ [Regulations for Admission to Master's Programmes](#)

- accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Molecular Science and Technology and
 - obtained the degree with an average final grade of at least 7.0 (Dutch grading system) and
 - a research project/internship grade of at least 7.5
- such to be judged by the Board of Admissions.

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in Article 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1, subsections a and b, without prejudice to the qualitative conditions specified in Article 3.2.4.

Article 3.2.2 may, amongst others, apply to holders of a degree from a foreign research university that does not meet the requirements specified in Article 3.2.1 subsection b or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in an MST- or chemistry-related programme provided that the candidate has

- obtained the degree with an average final grade of at least 7.5 (Dutch grading system) and
- a research project/internship grade of at least 8.0

Admission process

Applicants as referred to in Article 3.2.1.b and Article 3.2.2 are requested to provide the Board of Admissions with the following:

- Copies of diploma(s) and transcript(s) of grades,
- A placement letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1 subsection a,
- A curriculum vitae,
- Letter of recommendation by the internship supervisor (group or team leader),
- Hbo students as referred to in Article 3.2.2 should also submit a letter of recommendation of the mentor ('studieloopbaanbegeleider') of the BAS programme.

3.2.3 Dutch and English languages¹⁴

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;

¹⁴ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5 (minimum score on each subtest: 6.0)
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Advanced.

3.2.4 Qualitative admission requirements

Not applicable.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in Article 3.2.1 subsection b, or an equivalent diploma with a maximum of 15 EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in Article 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in Article 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of Article 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

Not applicable.

4. Specialisation Research in Chemistry (CHEM)

4.1 Description (Course and Examination Regulations chapter 2)

The research specialisation offers the student the opportunity to spend two full years on training and specialisation not only to become an independent and creative researcher, but also someone who can use their analytical skills to resolve challenges in their career in science or in society. The majority of the students with an MSc in Research in Chemistry will continue their career in a PhD position.

4.2 Programme (Course and Examination Regulations chapter 3)

The Research in Chemistry programme (CHEM) consists of the parts specified in Table 2.

Table 2: Overview of the programme of the MSc Chemistry Research specialisation

| Catalogue number | Component | Study load | Level |
|------------------|-----------------------------------|------------|---------|
| | Research training: | 60-80 EC* | 600 |
| | Major research project | 40-60 EC | 600 |
| | Minor research project (optional) | 20-40 EC | 600 |
| 4603SCMT4 | Science Methodology | 4 EC | 400 |
| 4423ACWR2 | Academic Writing | 2 EC | 400 |
| 4423ESCOL | Essay and colloquium | 6 EC | 500 |
| | Core courses (in research area) | 24 EC | 400-500 |
| | Electives | 24 EC | 400-600 |

* The total weight of research projects may not exceed 80 EC.

4.3 Research Training

4.3.1 Scope and study load: The research training is carried out in a LIC research group in the chosen research area (*Chemical Biology* or *Energy & Sustainability*). The research training may be split into a major and one or more minor projects. The major research project is limited to a minimum of 40 EC and a maximum of 60 EC; an optional minor research project must comprise at least 20 EC. A minor training project can be carried out in another research group, another research area, another institute (within the Netherlands or abroad), or in a company. All external research projects need prior approval from the Board of Examiners.

4.3.2 Supervision and evaluation: Each research training project must be supervised by a scientific staff member (main supervisor). Major research projects are evaluated and graded by at least the main supervisor and two Thesis Talk jury members. These Thesis Talk jury members are staff members who were not directly involved in the research project. They judge the quality of the research report, the quality of the presentation and the scientific level of the student and decide the final grade together with the main supervisor. Minor research projects carried out within the LIC are evaluated and graded by two LIC scientific staff members who were not the main supervisor for the major research training project. External research training projects are supported, evaluated and graded by a scientific staff member of the LIC who was not the main supervisor for any other research training project (the internal supervisor) and a staff member from the host institute (the external supervisor). The internal supervisor has the final responsibility for creating the research project agreement, grading the research project report and creating, signing and submitting the project evaluation form.

4.3.3 Written report: All research training projects are concluded with a written report; for the major research training this is the MSc thesis. The requirements for the written report are specified in the Prospectus. The final version of the report should be handed in within 3 months after the last day of practical work.

4.3.4 Thesis Talk: The major research project is concluded with an oral presentation for the main supervisor, the Thesis Talk jury members and an audience of interested students and staff members of the LIC (i.e. Thesis Talk). Students should attend at least 7 Thesis Talks as part of their major research project.

4.3.5 Obligatory sequence (Course and Examination Regulations art. 4.2): Students can only start with an optional minor research training project (within or outside the LIC) when the major project has been successfully concluded with a grade (including a Thesis Talk). Exceptions can only be granted by the Board of Examiners following article 4.2.2 of the Faculty OER.

4.4 Theoretical compulsory components

The compulsory theoretical component comprises a selection of four core courses, courses on academic skills (Science Methodology and Academic Writing) and a literature essay with a colloquium.

The colloquium supervisor cannot be the main supervisor of any of the student's research projects. The final grade for the colloquium is determined by a colloquium jury composed of two LIC staff members. The jury cannot include the colloquium supervisor or the main supervisor of any research project. Students should attend at least 7 colloquia as part of their own colloquium and essay component.

The core courses (in total 24 EC) are selected within the chosen research area: Chemical Biology (CB) or Energy & Sustainability (ES). A list of the core courses offered by the two research areas is given in Table 3.

Table 3: Core courses compulsory for the research areas *Chemical Biology (CB)* and *Energy & Sustainability (ES)*. All courses encompass 6 EC.*

| Course title | Catalogue number | Level | Research area |
|---------------------------------------------------|------------------|-------|---------------|
| Chemical Biology | 4423CHEMBY | 500 | CB |
| Computational Techniques for Chemical Biology | 4423CTFCBY | 400 | CB |
| Enzyme Dynamics: NMR Spectroscopy and Kinetics | 4423EDNMRY | 500 | CB |
| Medicinal Chemistry & Drug Discovery | 4423MCHDDY | 500 | CB |
| Modern Organic Chemistry | 4423MODOCY | 500 | CB |
| Molecular Cell Biology** | 4423MOLCBY | 400 | CB |
| Reactivity in Organic Chemistry | 4423RIOCHY | 500 | CB |
| Supramolecular Chemistry | 4423SUPC6Y | 500 | CB |
| Computational Chemistry and Molecular Simulations | 4423CCAMSY | 400 | ES |
| Density Functional Theory in Practice | 4423DFTP6Y | 500 | ES |
| Electrochemistry | 4423ELECHY | 500 | ES |
| Heterogeneous Catalysis | 4423HETCAY | 500 | ES |
| Organometallic Chemistry & Homogeneous Catalysis | 4423ORGHOY | 500 | ES |
| Photochemistry | 4423PHCH6Y | 500 | ES |
| Photosynthesis & Bioenergy | 4423PBE06Y | 500 | ES |
| Surface Science | 4423SURFSY | 500 | ES |

* Courses that were taken in the BSc programme cannot be taken again in the MSc programme.

** This course cannot be chosen by students with a BSc degree in Life Science and Technology or

equivalent. This course cannot be combined with either of the courses Cell Biology and Molecular Biology (offered up to 2019-20).

4.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK" (catalogue number 4423WORKV: "Career Orientation & Competence Reflection"). Students have to *Write* an application letter and CV, attend seminars and workshops for job market *Orientation*, and have to *Reflect* on their skills, strengths and weaknesses. After finalisation of this component they will have acquired improved *Knowledge* of what they are good at and what kind of career they would like to pursue! This component comprises a number of activities and workshops to create awareness of the job market and give students insight into their skills, abilities and weaknesses. During the two years of the MSc programme, a number of different activities are offered. The activities include alumni events (e.g. lectures, speed-dating), workshops offered by the Career Service, self-assessment and self-reflection tasks, participation in excursions to companies and visits to career fairs such as the 'β-banenmarkt'. All students have to do a self-evaluation test at the start of their programme, take part in the workshop 'CV, LinkedIn profile and cover letter' during their studies, and write a self-reflection after their major research project. In addition, students take at least six of the workshops or other activities that are offered by the programme, Career Service or other partners during their studies, within the boundaries specified by the programme.

4.6 Electives

The electives can comprise either theoretical or practical courses or an extension of the duration of a research project with a maximum of 20 EC and within the limitations described in section 4.3. Elective courses can be chosen from the core courses within or outside the chosen research area, approved elective MSc courses of the Leiden University Faculty of Science published in the Prospectus, MSc courses offered in a Science Faculty of any Dutch or foreign university of level 400 or higher, level 400 courses from the BSc MST or LST programmes, or other relevant courses approved by the Board of Examiners on an individual basis. Elective courses are restricted to courses that were not part of the student's earlier studies and do not overlap in content with other courses already taken as part of the MSc curriculum.

Students can verify the suitability of their programme with the Board of Examiners when they have doubts about a combination of courses. Students must gain approval from the Board of Examiners prior to taking any components offered by universities outside the Netherlands, as well as starting any external research project (i.e. outside the LIC).

5. Specialisation Chemistry and Business Studies

5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Business Studies (BS) offers students the possibility to combine chemistry with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

5.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Business Studies (BS) programme consists of the parts specified in Table 4. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Table 4. Overview of the programme of the specialisation Chemistry and Business Studies

| Catalogue number | Component | Study load | Level |
|----------------------|---------------------------------|-----------------|---------|
| | Research training | 30 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses (in research area) | 24 EC | 400-500 |
| | Electives | 0-20 EC | 400-600 |
| BS components | | | |
| | BS courses | 20 EC | 500 |
| | BS internship | 20, 30 or 40 EC | 600 |
| | BS electives | 0-20 EC | 400-500 |

5.3 Research Training

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

5.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 in correspondence with the chosen research area and courses on academic skills (Science Methodology and Academic Writing).

5.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK". See the description and specifications in section 4.5.

5.6 Electives

Elective components may consist of additional courses within or outside the chosen research area, an extension of the research project, additional BS courses or an extension of the Business Internship. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

5.7 BS components

A minimum of 40 EC and a maximum of 60 EC within the BS component is required to complete the BS specialisation. A specification of the BS specialisation is described [here](#).

6. Specialisation Chemistry and Science Communication and Society

6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Science Communication and Society (SCS) offers students the possibility to combine chemistry and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

Students who complete the specialisation Chemistry and Science Communication and Society are admissible to a PhD programme in Chemistry or in Science Communication.

6.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Science Communication and Society (SCS) programme consists of the parts specified in Table 5. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Table 5: Overview of the programme of the specialisation Chemistry and Science Communication and Society

| Catalogue number | Component | Study load | Level |
|-----------------------|----------------------------------------------|------------|---------|
| | Research training | 30 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses (in research area) | 24 EC | 400-500 |
| | Electives | 0-20 EC | 400-600 |
| SCS components | | | |
| 4603SCISEY | Informal Science Education* | 4 | 400 |
| 4603SCPDSY | Policy & Development in science and Society* | 4 | 400 |
| 4603SCRSCY | Research in science communication* | 4 | 400 |
| 4603SCSJ4Y | Science Journalism (ENG)* | 4 | 400 |
| 4603SCSWJY | Wetenschapsjournalistiek (NL)* | 4 | 400 |
| 4603SCPRDY | Science Communication product development** | 4 | 400 |
| 4603SCNV3Y | SCS: Scientific Narration and Visualization* | 3 | 500 |
| | Internship | | |
| 4603SCSPPY | SCS Project Proposal | 3 | 600 |
| 4603SCSS1Y | SCS Internship(s) | 14-34 | 600 |
| | Additional elective | | |
| 4603SCSELY | SCS elective | 1-10 | 400-500 |

* **SCS courses** are available as elective course for students who don't follow the SCS specialisation.

** *the course **Science Communication product development** is only admissible for students who have completed all other SCS courses.*

6.3 Research Training

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis

Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

6.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 in correspondence with the chosen research area and courses on academic skills (the course Science Methodology and Academic Writing).

6.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK". See the description and specifications in section 4.5.

6.6 Elective components

Elective components may consist of additional theoretical courses within or outside the chosen research area, an extension of the research project, additional SCS courses or an extension of or additional SCS internships. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

6.7 SCS components

A minimum of 40 EC and a maximum of 60 EC within the SCS component is required to complete the SCS specialisation. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

7. Specialisation Chemistry and Education (NL)

7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Chemistry and Education (EDU) prepares students for a career as chemistry (scheikunde) teacher qualified to teach in Dutch secondary education.

7.2 Programme (Course and Examination Regulations chapter 3)

The Chemistry and Education (EDU) programme consists of the parts specified in Table 6. All programme-specific components must be finished before the specialisation-specific Education components can be started. Exceptions to this obligatory sequence can only be granted by the Board of Examiners of the MSc programme Chemistry.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

Table 6: Overview of the programme of the specialisation Chemistry and Education

| Catalogue number | Component | Study load | Level |
|----------------------------|---------------------|------------|---------|
| 60 EC EDU programme | | | |
| | Research training | 30 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 0 EC | |

EDU components

| | | | |
|------------------------------------------------------|-------------------------|-------|---------|
| | EDU theoretical courses | 28 EC | 300-600 |
| | EDU teaching practice | 32 EC | |
| 30 EC EDU programme | | | |
| | Research training | 40 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 20 EC | 400-600 |
| EDU components ('eerstegraads' only, see 7.6) | | | |
| | EDU theoretical courses | 15 EC | 400-600 |
| | EDU teaching practice | 15 EC | |

7.3 Research Training

The research training project in Chemistry should be carried out in one of the research groups of the Leiden Institute of Chemistry. It includes a written report (MSc thesis) and is finalised with a Thesis Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

7.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 and courses on academic skills (Science Methodology and Academic Writing). Students in the EDU specialisation are advised to select courses from both research areas to obtain a broader knowledge of chemistry.

7.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK". See the description and specifications in section 4.5.

7.6 Elective components

When the student has passed the minor Education (30 EC) during their BSc programme, the compulsory Education component is reduced with 30 EC. The remaining 30 EC are added to the Chemistry programme as electives, of which a minimum of 10 EC should be used for research training. Further elective components may consist of additional theoretical courses or further extension of the research project. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

7.7 EDU components

To complete the EDU specialisation, 60 EC within the EDU component is required. If a minor EDU was successfully taken in the BSc programme, the EDU component is limited to 30 EC. A specification of the EDU specialisation is described [here](#).

8. Transitional arrangements

8.1 The programme component Academic Skills is compulsory for students who started with the MSc Chemistry per September 2017 or later. Students who do not have this obligation add 6 EC to their free electives and are allowed to take the courses associated with the Academic Skills component as electives.

8.2 If a student has demonstrable prior knowledge of one or both subjects of the compulsory courses in the programme component Academic Skills, they can request permission from the Board of Examiners for an alternative set of courses to fill the Academic Skills component. The Academic skills component should encompass at least 6 EC, should be in the broad subject area of academic skills and is bound to the same requirements as stipulated for elective courses in section 4.6.

8.3 The compulsory co-curricular component "WORK" is not required for students who started before September 2019.

8.4 Students who started before September 2019 must attend at least 10 Thesis Talks, unless they voluntarily take the co-curricular component 'WORK', in which case they must attend at least 7 Thesis Talks.

8.5 Students who started before September 2019 and choose the research specialisation must attend at least 10 colloquia, unless they voluntarily take the co-curricular component 'WORK', in which case they must attend at least 7 colloquia.

8.6 Students who started before September 2020 in the EDU-30 programme are not required to use at least 10 EC of their electives to extend the research training component of the programme.

8.7 Students are allowed to compose their set of core courses for the final examination based on the set described in either the current OER or the applicable OER at the time they started their MSc programme, provided they did not interrupt their registration.

8.8 Molecular Cell Biology (MCB), catalogue number 4423MOLCB, can be used to replace either Molecular Biology (MB, 4423MOLBI) or Cell Biology (CEB, 4423CELBI) as a core course for any student who started before September 2020. Molecular Cell Biology cannot be included in the final examination together with Molecular Biology, Cell Biology or both.

8.9 After discontinuation of a component or major changes to a component, the student is provided with one more option to finish the component in the following academic year, where applicable via partial exams and/or compensatory assignments.

8.10 When a student does not use the opportunity mentioned in 8.9 or does not acquire a pass grade, the student is required to replace the missing ECs with another component following the requirements for their specialisation.

8.11 If a student for any reason, including the situation stipulated in 8.9 and 8.10, is not able to compose a programme conform the requirements, the Board of Examiners can grant an exception and approve an alternative programme. The Board of Examiners judges whether the alternative programme guarantees the student meets the learning outcomes of the programme.

MSc Computer Science

CROHO-number 60300

1. Description of the programme (Course and Examination Regulations art. 2)

The MSc programme Computer Science is taught in Leiden by the Leiden Institute of Advanced Computer Science (LIACS).

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The general objective of the MSc programme Computer Science is to teach master's students sufficient knowledge, insight, and skills to work independently at an academic level as computer scientists, and to contribute in an original manner to recognizing, defining, and solving problems in specific knowledge areas of computer science, to discuss this contribution with experts in the field, and to inform non-specialists in a clear and unambiguous manner on their own ideas, goals and the public impact of their research, and to follow a PhD programme within the field of Computer Science and its adjacent areas.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme Computer Science offers seven specialisations corresponding to major research themes at the LIACS: '*Advanced Computing and Systems (ACS)*', '*Artificial Intelligence (AI)*', '*Bioinformatics (BI)*', '*Data Science: Computer Science (DS)*', and '*Foundations of Computing (FoC)*'. The remaining two specialisations combine research in computer science with *Science Communication and Society (SCS)*, and *Education (EDU)*. In addition, LIACS offers two MSc programmes in *Media Technology* and in *ICT in Business and the Public Sector*, which are described separately in this appendix.

From 1 September 2020, the specialisation *Computer Science and Advanced Data Analytics* is no longer available to new students in the MSc Computer Science programme. Students who started this specialisation on 1 September 2019 or 1 February 2020 change specialisation based on their chosen core components: each of *Advanced Computing and Systems*, *Artificial Intelligence*, and *Foundations of Computing* changes to its respective specialisation with identical name, *Advanced Data Analytics* changes to *Data Science: Computer Science*. For students who started before 1 September 2019, the programme consists of specialisation courses and seminars (78 EC in total, from the list in Article 8.3), and a master's thesis research project in computer science (second year; 42 EC). They may choose to substitute 18 EC of specialisation courses and seminars by an *Introductory Research Project* (18 EC).

All specialisations have the same Director of Education, the same Board of Examiners, and the same Department Teaching Committee. Exceptions to this are formed by the specialisations SCS, and EDU, which for the specialisation-specific part each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science. A Board of Admissions will advise on admissions.

1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc programme Computer Science have attained the following general learning outcomes:

- a. theoretical and practical skills in more than one specialist area of computer science such that they can carry out research under overall supervision;
- b. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- c. the ability to interrelate and integrate various areas of computer science;

- d. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;
- e. sufficient understanding of the social and societal role of computer science to be able to reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;
- f. have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

1.4 Programme duration and completion (Course and Examination Regulations art. 2.5)

The duration of the *MSc programme Computer Science* is two years (120 EC). Students who complete the programme receive the degree Master of Science in Computer Science, with a description of the specialisation. Students who complete any of the specialisations in Computer Science are admissible to a PhD programme in Computer Science or related fields.

1.5 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February.

1.6 Language of the programme (Course and Examination Regulations art. 2.8)

The programme is taught in English with the exception of a few courses in the Education specialisation.

2. Admission to the programme (Course and Examination Regulations chapter 5)

2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.¹⁵

2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Computer Science (Informatica) or Artificial Intelligence from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a computer science-related programme from a research university in the Netherlands or from a foreign research university of similar level, provided

¹⁵The Regulations for Admission to Master's Programmes can be found on the website: [Regulations for Admission to Master's Programmes](#)

that the candidate has accumulated at least 90 EC (or the equivalence thereof) in courses/projects belonging to the domain of Computer Science, or

- c. holders of a bachelor's degree and additionally having passed the prescribed pre-master's programme pursuant to Article 2.4.1

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Article 2.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in computer science or bioinformatics related programmes. As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5. Deficiencies up to 30 EC can be removed upon discussion with the study advisor using a bridging programme (see 2.4).

Admission process

Applicants as referred to in Article 2.2.1.b and Article 2.2.2 are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 2.2.1.a.

2.2.3 **Dutch and English languages**¹⁶

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An [International Baccalaureate](#) diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking;
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking;

¹⁶ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169 .

2.2.3.3 As further clarification of Article 2.8 of the Course and Examination Regulations concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Advanced.

2.2.4 Qualitative admission requirements

Not applicable.

2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

2.4 Bridging programmes (Pre-master's)

2.4.1 The department has developed the following bridging programmes (for the following target groups) in order to remove deficiencies:

- For students with bachelor's degrees related to Computer Science the Board of Admissions may impose a Pre-Master's programme up to 30 EC, tailored to the individual backgrounds of the prospective students, to be completed before admission into the MSc programme.

2.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

3. Specialisation Advanced Computing and Systems

3.1 Description (Course and Examination Regulations art. 2)

The master's specialisation *Advanced Computing and Systems* offers future-oriented topics in computer science with a focus on high performance computing, embedded systems, and cloud and distributed computing. This specialisation focuses on the computer systems of tomorrow. These include the driver of the internet of things, such as high-performance computers capable of simultaneously processing huge volumes of data, cloud computing and large database systems satisfying today's demands on data analysis more than the more conventional transactions do, and embedded systems in which sensors and processors are integrated, making them 'smart' and sensitive to the change of the environment.

The main focus is on computing systems, which represents the unique expertise of one of the research groups of Leiden University. The strength of the programme is the individual possibility for each student to study other future-oriented topics in Foundations of Computing, Artificial Intelligence and Data Science. This specialisation of the MSc programme Computer Science provides students with a thorough computer science background that will allow them to pursue careers in research or industrial environments.

3.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation *Advanced Computing and Systems* have obtained in-depth knowledge in programming high performance computers and embedded systems, and building multimedia systems.

3.3 Programme (Course and Examination Regulations art. 3)

The programme is 120 EC in extent and consists of compulsory core courses (36 EC), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). The choice of the specialisation courses may be limited by the need to adapt the programme to the prior knowledge of the candidate:

| <u>Core courses Advanced Computing and Systems</u> | <u>Level</u> | <u>EC</u> |
|--------------------------------------------------------------|--------------|-----------|
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Distributed Data Processing Systems ¹⁷ 4343DISDPY | 500 | 6 |
| Embedded Systems and Software 4343EMBSSY | 500 | 6 |
| High Performance Computing I 4343HPCI6Y | 500 | 6 |
| High Performance Computing II 4343HPC2XY | 500 | 6 |
| Multimedia Systems 4343MMSY6Y | 500 | 6 |

Specialisation courses and seminars

A choice can be made from the specialisation courses and seminars below during the first and second year of the programme for at least 42 EC¹⁸. The specialisation courses and seminars have level 400 - 500, and range from 3 - 6 EC each.

| | <u>Level</u> | <u>EC</u> |
|--------------------------------------------------------------|--------------|-----------|
| <u>Advanced Data Management for Data Analysis 4343ADMDXY</u> | 500 | 6 |

¹⁷ Students who started before 1 September 2020 are allowed to substitute *Robotics*, which was previously mandatory, by *Distributed Data Processing Systems*.

¹⁸ Students who started before 1 September 2020 may choose to instead do an *Introductory Research Project* of 18 EC and specialisation courses and seminars for at least 24 EC.

| | | |
|-------------------------------------------------------------------------------------------------|-----|---|
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Advances in Deep Learning ¹⁹ 4343ADL6XY | 500 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Audio Processing and Indexing 4343AUDIOY | 500 | 6 |
| Automated Machine Learning 4343AUTMXY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |
| Bio-Modeling 4343BIOMDY | 500 | 6 |
| Competitive Programming ¹⁹ 4343CPML6Y | 500 | 6 |
| Complex networks (BM) 4609COMNWX | 400 | 6 |
| Computational Creativity 4383COMCRY | 500 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| Computational Models and Semantics 4343CMS6XY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Cryptographic Engineering 4343CRYPEY | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| Foundations of Software Testing 4343FSWT6Y | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Information Retrieval ²⁰ 4343INFREY | 500 | 6 |
| Information Theoretic Data Mining 4343ITDM6Y | 500 | 6 |
| Introduction to Deep Learning ²¹ 4343INTDLY | 500 | 6 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Modern Game AI Algorithms 4343MGAIXY | 500 | 6 |
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Multimedia Information Retrieval ¹⁹ 4343MMIRLY | 500 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Quantum Computing 4343QUCO3Y | 500 | 6 |
| Reinforcement Learning 4343REINLY | 500 | 3 |
| Robotics 4343ROBO6Y | 500 | 6 |
| Seminar Advanced Deep Reinforcement Learning ¹⁹ 4343SADRLY | 500 | 6 |
| Seminar Combinatorial Algorithms 4343SCOMAY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Software Development & Product Management 4353SWDPMY | 500 | 6 |
| Software Verification ²³ 4343SWVERY | 500 | 6 |
| Sports Data Science ¹⁹ 4343SPDSCY | 500 | 6 |
| System and Software Security 4343SYSSSY | 500 | 6 |
| Text Mining 4343TXTMNY | 500 | 6 |
| Urban Computing 4343URBC6Y | 500 | 6 |

¹⁹ This course has limited availability. Details on the admission procedure can be found on the prospectus.

²⁰ This course is not available to students who completed *Information Retrieval and Text Analytics* (Level 500, 6 EC) before 1 September 2021.

²¹ This course is not available to students who completed either *Neural Networks* (Level 500, 6 EC) or *Deep Learning and Neural Networks* (Level 500, 6 EC) before 1 September 2020.

²² This course is available only in the Spring of odd years (2023, 2025, ...)

²³ This course is not available to students who completed *Advances in Model Checking* (Level 500, 6 EC) before 1 September 2020.

| | | |
|-------------------------------------|-----|---|
| Video Games for Research 4383VGFR6Y | 500 | 6 |
| | 500 | 6 |

| | | |
|---------------------------------------------------------------------------------------------------------------|--------------|-----------|
| <u>Master's thesis research project</u> | <u>Level</u> | <u>EC</u> |
| Master's Thesis Research Project 4343MRP42Y (including Master Class, written thesis and oral presentation) | 600 | 42 |

4. Specialisation Artificial Intelligence

4.1 Description (Course and Examination Regulations art. 2)

The master's specialisation *Artificial Intelligence* offers future-oriented topics in computer science with a focus on machine learning, optimization algorithms, and decision support techniques. Artificial intelligence techniques are capable of making incredibly accurate predictions on the basis of data they themselves have gathered. In other words, computers can learn without intervention once they have been pre-programmed by humans. In this specialisation we explore the borders of what a revolutionary new generation of artificial intelligent algorithms can achieve. The specialisation also deals with optimisation, which offers theory and methods for the search for the best combination of a variety of factors in, e.g., some production process.

The main focus is on Machine Learning and Optimisation, which represent the unique expertise of several research groups of Leiden University. The strength of the programme is the individual possibility for each student to study other future-oriented topics in Advanced Computing Systems, Foundations of Computing, and Data Science. This specialisation of the MSc programme Computer Science provides students with a thorough computer science background that will allow them to pursue careers in research or industrial environments.

4.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation *Artificial Intelligence* have obtained in-depth knowledge on deep and reinforcement learning methods, understanding the principles of evolutionary computation and its application for optimisation algorithms.

4.3 Programme (Course and Examination Regulations art. 3)

The programme is 120 EC in extent and consists of compulsory core courses (36 EC), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). The choice of the specialisation courses may be limited by the need to adapt the programme to the prior knowledge of the candidate. Every student of the specialisation *Artificial Intelligence* has to complete the following compulsory core courses:

| <u>Core courses Artificial Intelligence</u> | <u>Level</u> | <u>EC</u> |
|--------------------------------------------------------|--------------|-----------|
| Automated Machine Learning 4343AUTMX | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| Introduction to Deep Learning ²⁴ 4343INTDLY | 500 | 6 |
| Modern Game AI Algorithms 4343MGAIXY | 500 | 6 |

²⁴ Students who completed either *Neural Networks* (Level 500, 6 EC) or *Deep Learning and Neural Networks* (Level 500, 6 EC) before 1 September 2020 substitute this course by the one already taken.

| | | |
|-------------------------------------------------------------|-----|---|
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Reinforcement Learning 4343REINLY | 500 | 6 |

Specialisation courses and seminars

A choice can be made from the specialisation courses and seminars below during the first and second year of the programme for at least 42 EC¹⁸. The specialisation courses and seminars have level 400 - 500, and range from 3 - 6 EC each.

| | <u>Level</u> | <u>EC</u> |
|-------------------------------------------------------------------------------------------------|--------------|-----------|
| Advanced Data Management for Data Analysis 4343ADMDXY | 500 | 6 |
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Advances in Deep Learning ¹⁹ 4343ADL6XY | 500 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Audio Processing and Indexing 4343AUDIOY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |
| Bio-Modeling 4343BIOMDY | 500 | 6 |
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Competitive Programming ¹⁹ 4343CPML6Y | 500 | 6 |
| Complex networks (BM) 4609COMNWW | 400 | 6 |
| Computational Creativity | 500 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| Computational Models and Semantics 4343CMS6XY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Cryptographic Engineering 4343CRYPEY | 500 | 6 |
| Distributed Data Processing Systems 4343DISDPY | 500 | 6 |
| Embedded Systems and Software 4343EMBSSY | 500 | 6 |
| Foundations of Software Testing 4343FSWT6Y | 500 | 6 |
| High Performance Computing I 4343HPCI6Y | 500 | 6 |
| High Performance Computing II 4343HPC2XY | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Information Retrieval ²⁰ 4343INFREY | 500 | 6 |
| Information Theoretic Data Mining 4343ITDM6Y | 500 | 6 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Multimedia Information Retrieval ¹⁹ 4343MMIRLY | 500 | 6 |
| Multimedia Systems 4343MMSY6Y | 500 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Quantum Computing 4343QUCO3Y | 500 | 3 |
| Robotics 4343ROBO6Y | 500 | 6 |
| Seminar Advanced Deep Reinforcement Learning ¹⁹ 4343SADRLY | 500 | 6 |
| Seminar Combinatorial Algorithms 4343SCOMAY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Software Development & Product Management 4353SWDPMY | 500 | 6 |
| Software Verification ²³ 4343SWVERY | 500 | 6 |
| Sports Data Science ¹⁹ 4343SPDSCY | 500 | 6 |
| System and Software Security 4343SYSSSY | 500 | 6 |

| | | |
|-------------------------------------|-----|---|
| Text Mining 4343TXTMNY | 500 | 6 |
| Urban Computing 4343URBC6Y | 500 | 6 |
| Video Games for Research 4383VGFR6Y | 500 | 6 |

| | | |
|---------------------------------------------------------------------------------------------------------------|--------------|-----------|
| <u>Master's thesis research project</u> | <u>Level</u> | <u>EC</u> |
| Master's Thesis Research Project 4343MRP42Y (including Master Class, written thesis and oral presentation) | 600 | 42 |

5. Specialisation Bioinformatics

5.1 Description (Course and Examination Regulations chapter 2)

The focus of this programme is on data analysis and modelling of biological processes, which represents the unique expertise of the Bioinformatics research group at LIACS. This expertise is used to address issues like data acquisition, data warehousing, data analysis, data mining, and data modelling, which all have become major challenges in the field of bioinformatics due to the tremendous complexity and abundance of quantitative data in biology and medicine. On the other hand, bioinformatics heavily contributes to the identification of new fundamental computer science principles and the development of new informatics tools. Bioinformatics offers a unique new synthetic approach for formulating hypotheses and solving problems in (molecular-) biology versus the classical reductionist approach.

5.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Bioinformatics have obtained in-depth knowledge of the core concepts of bioinformatics, including methods in computational biology, the design and mining of bio databases, the process and analysis of images, and the construction of mathematical models of biological systems.

5.3 Programme (Course and Examination Regulations chapter 3)

The programme is 120 EC in extent and consists of compulsory core courses (36 EC in total), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). Every student of the specialisation *Bioinformatics* has to complete the following compulsory core courses:

| <u>Core courses Bioinformatics</u> | <u>Level</u> | <u>EC</u> |
|-----------------------------------------------------------|--------------|-----------|
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Bio-Modeling 4343BIOMDY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Introduction to Deep Learning ²⁴ 4343INTDLY | 500 | 6 |

Specialisation courses and seminars

A choice can be made from several specialisation courses, seminars and a research project during the first and second year of the programme for at least 42 EC. The specialisation courses and seminars have level 400 - 500 and range from 3 - 6 EC each. The selection of the specialisation courses and seminars takes place in coordination with the Bioinformatics study adviser.

| | |
|--------------|-----------|
| <u>Level</u> | <u>EC</u> |
|--------------|-----------|

| | | |
|----------------------------------------------------------------------------------------------------|--------------|-----------|
| Advanced Data Management for Data Analysis 4343ADMDXY | 500 | 6 |
| Advances in Deep Learning ¹⁹ 4343SADL6Y | 500 | 6 |
| Automated Machine Learning 4343AUTMXY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Complex Networks (BM) 4609COMNWX | 400 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| High-dimensional data analysis 4433HDDANY | 500 | 6 |
| Introductory Research Project ²⁵ 4343IRPRJY | 500 | 12/15/18 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Metabolic Network Analysis (BM) 4373CSMNAY | 400 | 6 |
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Multiscale Mathematical Biology (BM) 4373MUBI6 | 400 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Reinforcement Learning 4343REINLY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Statistical Genetics 4433STAGEY | 500 | 6 |
| Text Mining 4343TXTMNY | 500 | 6 |
| <i>Master's thesis research project</i> | <i>Level</i> | <i>EC</i> |
| Master's Thesis Research Project (including Master Class, written thesis and oral presentation) | 600 | 42 |

6. Specialisation Data Science: Computer Science

6.1 Description (Course and Examination Regulations chapter 2)

The focus of the *Data Science* master's specialisation is on state-of-the-art knowledge on the foundations and algorithmic aspects of data mining, machine learning, and statistical data analysis. Data science is an interdisciplinary discipline at the intersection of statistical science and computer science aiming at discovering knowledge from typically large sets of structured or unstructured data. To achieve this goal, data scientists combine statistical methods and machine learning with exploration and optimization algorithms from computer science.

The specialisation *Data Science: Computer Science* equips students interested in data analysis with state-of-the-art knowledge in advanced statistical techniques, machine learning, and algorithmic aspects of data analysis. The strength of the programme is the individual possibility for each student to study other future-oriented topics in Advanced Computing Systems, Foundations of Computing, and Artificial Intelligence.

6.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation Data Science: Computer Science have obtained in-depth knowledge of data

²⁵ The topic of the project and the credits to be assigned to it (either 12, 15 or 18 EC) have to be decided together with the Study Advisor.

management, have a thorough understanding of algorithmical analysis of data and are able to develop new data model and techniques and execute data analysis.

6.3 Programme (Course and Examination Regulations chapter 3)

The programme is 120 EC in extent and consists of compulsory core courses (36 EC in total), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). The choice of the specialisation courses may be limited by the need to adapt the programme to the prior knowledge of the candidate. Every student of the specialisation *Data Science* has to complete the following compulsory core courses²⁶:

| <u>Core courses Data Science</u> | <u>Level</u> | <u>EC</u> |
|------------------------------------------------------------|--------------|-----------|
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Information Retrieval ²⁰ 4343INFREY | 500 | 6 |
| Introduction to Deep Learning ²¹ 4343INTDLY | 500 | 6 |
| Reinforcement Learning 4343REINLY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Text Mining 4343TXTMNY | 500 | 6 |

Specialisation courses and seminars

A choice can be made from several specialisation courses and seminars during the first and second year of the programme for at least 42 EC¹⁸. The specialisation courses and seminars have level 400 - 500 and range from 3 - 6 EC each. The selection of the specialisation courses and seminars takes place in coordination with the study advisor.

| | <u>Level</u> | <u>EC</u> |
|------------------------------------------------------|--------------|-----------|
| Advanced Data Management for Data Analysis 4343ADMXY | 500 | 6 |
| Advanced Statistical Computing 4433ADSTCY | 500 | 3 |
| Advances in Deep Learning ¹⁹ 4343SADL6Y | 500 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Automated Machine Learning 4343AUTMXY | 500 | 6 |
| Audio Processing and Indexing 4343AUDIOY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |
| Bio-modeling 4343BIOMDY | 500 | 6 |
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Competitive Programming ¹⁹ 4343CPML6Y | 500 | 6 |
| Complex networks (BM) 4609COMNWWY | 400 | 6 |
| Computational Creativity 4383COMCRY | 500 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Cryptographic Engineering 4343CRYPEY | 500 | 6 |
| Data Science in Practice ²⁷ 4343DASPRY | 500 | 6 |
| Distributed Data Processing Systems 4343DISDPY | 500 | 6 |

²⁶ Students who started *Data Science: Computer Science* before 1 September 2021 are allowed to substitute one or more of their old mandatory courses, *Advanced Statistical Computing*, *Deep Learning and Neural Networks*, *Information Theoretic Data Mining*, *Information Retrieval and Text Analysis*, *Linear & Generalized Linear Models and Linear Algebra*, and *Statistical Learning* with current core courses.

²⁷ This course is not available to students who completed either *Introduction to Data Science* (Level 400, 6 EC) or *Introduction to Data Science for Computer Scientists* (Level 400, 6 EC) before 1 September 2020.

| | | |
|---------------------------------------------------------------------------------------------------------------|--------------|-----------|
| Embedded Systems and Software 4343EMBSSY | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| Foundations of Software Testing 4343FSWT6Y | 500 | 6 |
| High Performance Computing I 4343HPCI6Y | 500 | 6 |
| High Performance Computing II 4343HPC2XY | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Information Theoretic Data Mining 4343ITDM6Y | 500 | 6 |
| Linear & Generalized Linear Models and Linear Algebra 4433LAGLMY | 400 | 9 |
| Modern Game AI Algorithms 4343MGAIXY | 500 | 6 |
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Multimedia Information Retrieval ¹⁹ 4343MMIRLY | 500 | 6 |
| Multimedia Systems 4343MMSY6Y | 500 | 6 |
| Multivariate and Multidimensional Data Analysis 4433MAMDAY | 500 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Quantum Computing 4343QUCO3Y | 500 | 3 |
| Robotics 4343ROBO6Y | 500 | 6 |
| Seminar Advanced Deep Reinforcement Learning ¹⁹ 4343SADRLY | 500 | 6 |
| Seminar Combinatorial Algorithms 4343SCOMAY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Software Development & Product Management 4353SWDPMY | 500 | 6 |
| Software Verification ²³ 4343SWVERY | 500 | 6 |
| Sports Data Science ¹⁹ 4343SPDSCY | 500 | 6 |
| Statistical Learning 4433STLT6Y | 500 | 6 |
| System and Software Security 4343SYSSSY | 500 | 6 |
| Urban Computing 4343URBC6Y | 500 | 6 |
| Video Games for Research 4383VGFR6Y | 500 | 6 |
| <i>Master's thesis research project</i> | <i>Level</i> | <i>EC</i> |
| Master's Thesis Research Project 4343MRP42Y (including Master Class, written thesis and oral presentation) | 600 | 42 |

7. Specialisation Foundations of Computing

7.1 Description (Course and Examination Regulations art. 2)

The master's specialisation *Foundations of Computing* focuses on the core concepts of computing, their applications in AI, quantum computing, parallel computing, and in verification and testing to ensure correctness of digital systems. By focusing on core concepts that transcend the boundaries of various Computer Science fields, the Foundations specialisation prepares you for an inter-disciplinary future. In particular, students will learn to model complex software systems and apply automated proof techniques to verify their correctness, thereby increasing trust in digital systems. Using the power of symbolic computation, the specialisation tackles hard computational problems and lays the basis to realise reasoning for artificial intelligence. It also equips students with knowledge of

concurrency required to analyse parallel systems, but also with knowledge about non-deterministic, probabilistic and quantum computational models, all with the goal of solving problems more efficiently than with classical techniques.

The Foundations of Computing specialisation offers a unique blend of state-of-the-art topics in Computer Science reflecting the unique expertise one of the research groups of Leiden University. The strength of the programme is the individual possibility for each student to study other future-oriented topics in Advanced Computing Systems, Artificial Intelligence, and Data Science. The programme provides students with a thorough computer science background that will allow them to pursue careers in research or industrial environments, and will give them the ability to handle future technologies and to work across disciplines.

7.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the MSc programme Computer Science with the specialisation *Foundations of Computing* have obtained in-depth knowledge of verification methods and modelling techniques, and understanding of advanced data structures and algorithms.

7.3 Programme (Course and Examination Regulations art. 3)

The programme is 120 EC in extent and consists of compulsory core courses (36 EC), specialisation courses and seminars (42 EC in total), and a master's thesis research project in computer science (second year; 42 EC in total). The choice of the specialisation courses may be limited by the need to adapt the programme to the prior knowledge of the candidate. Every student of the specialisation *Foundations of Computing* has to complete the following compulsory core courses:

| <u>Core courses Foundations of Computing</u> | <u>Level</u> | <u>EC</u> |
|----------------------------------------------------|--------------|-----------|
| Computational Models and Semantics 4343CMS6XY | 500 | 6 |
| Foundations of Software Testing 4343FSWT6Y | 500 | 6 |
| Modern Game AI Algorithms ²⁸ 4343MGAIXY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Software Verification ²³ 4343SWVERY | 500 | 6 |
| Seminar Combinatorial Algorithms 4343SCOMAY | 500 | 6 |

Specialisation courses and seminars

A choice can be made from the specialisation courses and seminars below during the first and second year of the programme for at least 42 EC⁴. The specialisation courses and seminars have level 400 - 500, and range from 3 - 6 EC each.

| | <u>Level</u> | <u>EC</u> |
|-------------------------------------------------------|--------------|-----------|
| Advanced Data Management for Data Analysis 4343ADMDXY | 500 | 6 |
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Advances in Deep Learning ¹⁹ 4343SADL6Y | 500 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Audio Processing and Indexing 4343AUDIOY | 500 | 6 |
| Automated Machine Learning 4343AUTMXY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |
| Bio-Modeling 4343BIOMDY | 500 | 6 |

²⁸ Students who have successfully followed the course *Concurrency and Causality* before September 2021 do not need to follow this course.

| | | |
|---------------------------------------------------------------------------------------------------------------|--------------|-----------|
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Competitive Programming ¹⁹ 4343CPML6Y | 500 | 6 |
| Complex networks (BM) 4609COMNWX | 400 | 6 |
| Computational Creativity 4383COMCRY | 500 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Cryptographic Engineering 4343CRYPEY | 500 | 6 |
| Distributed Data Processing Systems 4343DISDPY | 500 | 6 |
| Embedded Systems and Software 4343EMBSSY | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| High Performance Computing I 4343HPCI6Y | 500 | 6 |
| High Performance Computing II 4343HPC2XY | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Information Retrieval ²⁰ 4343INFREY | 500 | 6 |
| Information Theoretic Data Mining 4343ITDM6Y | 500 | 6 |
| Introduction to Deep Learning ²¹ 4343INTDLY | 500 | 6 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Multimedia Information Retrieval ¹⁹ 4343MMIRLY | 500 | 6 |
| Multimedia Systems 4343MMSY6Y | 500 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Computing 4343QUCO3Y | 500 | 3 |
| Reinforcement Learning 4343REINLY | 500 | 6 |
| Robotics 4343ROBO6Y | 500 | 6 |
| Seminar Advanced Deep Reinforcement Learning ¹⁹ 4343SADRLY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Software Development & Product Management 4353SWDPMY | 500 | 6 |
| Sports Data Science ¹⁹ 4343SPDSCY | 500 | 6 |
| System and Software Security 4343SYSSSY | 500 | 6 |
| Text Mining 4343TXTMNY | 500 | 6 |
| Urban Computing 4343URBC6Y | 500 | 6 |
| Video Games for Research 4383VGFR6Y | 500 | 6 |
| <i>Master's thesis research project</i> | <i>Level</i> | <i>EC</i> |
| Master's Thesis Research Project 4343MRP42Y (including Master Class, written thesis and oral presentation) | 600 | 42 |

8. Specialisation Computer Science and Science Communication and Society

8.1 Description (Course and Examination Regulations chapter 2)

The specialisation *Computer Science and Science Communication and Society* (SCS) offers students the possibility to combine computer science and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communication mind-set.

Students who complete the specialisation *Computer Science and Science Communication and Society* are admissible to a PhD programme in computer science or in science communication.

8.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to the general achievements, graduates of the *MSc programme Computer Science* with the specialisation *Science Communication and Society* have reached the following specific achievement levels:

1. Knowledge of and skills in science communication theory and methods and is able to apply it;
2. Experience with science communication practice;
3. Knowledge of ethical, historical and social aspects in the area of the natural sciences.

8.3 Programme (Course and Examination Regulations chapter 3)

The *Computer Science and Science Communication and Society* (SCS) programme consists of:

- a minimum of 40 EC and a maximum of 60 EC of *SCS specialisation* components (see below)
- at least 30 EC of level-400-500 *specialisation courses* and seminars in Computer Science to be selected in correspondence with the Master's thesis research topic (see list below);
- a Master's thesis research project in Computer Science of 30 EC, level 600 (including *Master Class*, written thesis and oral presentation) in one of the research groups of LIACS.

| <u>SCS Components</u> | <u>Level</u> | <u>EC</u> | <u>Catalog nr</u> |
|----------------------------------------------|--------------|-----------|-------------------|
| Informal Science Education* | 400 | 4 | 4603SCISEY |
| Policy & Development in science and Society* | 400 | 4 | 4603SCPDSY |
| Research in science communication* | 400 | 4 | 4603SCRSCY |
| Science Journalism (ENG)* | 400 | 4 | 4603SCSJ4Y |
| Wetenschapsjournalistiek (NL)* | 400 | 4 | 4603SCSWJY |
| Science Communication product development** | 400 | 4 | 4603SCPRDY |
| SCS: Scientific Narration and Visualization* | 500 | 3 | 4603SCNV3Y |
| Internship | | | |
| SCS Project Proposal | 600 | 3 | 4603SCSPPY |
| SCS Internship(s) | 600 | 14-34 | 4603SCSS1Y |
| Additional elective | | | |
| SCS elective | 400-500 | 1-10 | 4603SCSELY |

* *SCS courses* are available as elective course for students who don't follow the *SCS specialisation*.

** the course *Science Communication product development* is only admissible for students who have completed all other *SCS courses*.

A choice can be made from the specialisation courses and seminars below.

| <u>Specialisation courses and seminars in Computer Science</u> | <u>Level</u> | <u>EC</u> |
|----------------------------------------------------------------|--------------|-----------|
| Advanced Data Management for Data Analysis 4343ADMDXY | 500 | 6 |
| Advances in Data Mining 4343ADVDMY | 500 | 6 |
| Advances in Deep Learning ¹⁹ 4343SADL6Y | 500 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Audio Processing and Indexing 4343AUDIOY | 500 | 6 |
| Automated Machine Learning 4343AUTMXY | 500 | 6 |
| Better Science for Computer Scientists 4343BSCS3Y | 500 | 3 |

| | | |
|-------------------------------------------------------------------------------------------------|-----|---|
| Bio-modeling 4343BIOMDY | 500 | 6 |
| Cloud Computing 4343CLCMPY | 500 | 6 |
| Competitive Programming ¹⁹ 4343CPML6Y | 500 | 6 |
| Complex Networks (BM) 4609COMNWX | 400 | 6 |
| Computational Creativity 4383COMCRY | 500 | 6 |
| Computational Imaging and Tomography 4343CIMTOY | 500 | 6 |
| Computational Models and Semantics 4343CMS6XY | 500 | 6 |
| Computational Molecular Biology 4343COMOBY | 500 | 6 |
| Cryptographic Engineering 4343CRYPEY | 500 | 6 |
| Distributed Data Processing Systems 4343DISDPY | 500 | 6 |
| Embedded Systems and Software 4343EMBSSY | 500 | 6 |
| Evolutionary Algorithms 4343EVAL6Y | 500 | 6 |
| Foundations of Software Testing 4343FSWT6Y | 500 | 6 |
| High Performance Computing I 4343HPCI6Y | 500 | 6 |
| High Performance Computing II 4343HPC2XY | 500 | 6 |
| Image Analysis with Applications in Microscopy 4343MMAV6Y | 500 | 6 |
| Information Retrieval ²⁰ 4343INFREY | 500 | 6 |
| Information Theoretic Data Mining 4343ITDM6Y | 500 | 6 |
| Introduction to Deep Learning ²³ 4343INTDLY | 500 | 6 |
| Introduction to Machine Learning 4343INTMLY | 500 | 6 |
| Modern Game AI Algorithms 4343MGAIXY | 500 | 6 |
| Multicriteria Optimization and Decision Analysis 4343MOADAY | 500 | 6 |
| Multimedia Information Retrieval ¹⁹ 4343MMIRLY | 500 | 6 |
| Multimedia Systems 4343MMSY6Y | 500 | 6 |
| Psychology of Programming 4343PSYPRY | 500 | 6 |
| Quantum Algorithms 4343QUALGY | 500 | 6 |
| Quantum Computing 4343QUCO3Y | 500 | 3 |
| Reinforcement Learning 4343REINLY | 500 | 6 |
| Robotics 4343ROBO6Y | 500 | 6 |
| Seminar Advanced Deep Reinforcement Learning ¹⁹ 4343SADRLY | 500 | 6 |
| Seminar Combinatorial Algorithms 4343SCOMAY | 500 | 6 |
| Seminar Swarm-based Computation with Applications in Bioinformatics ²² 4343SBCWAY | 500 | 6 |
| Social Network Analysis for Computer Scientists 4343SNACSY | 500 | 6 |
| Software development and Product Management 4353SWDPMY | 500 | 6 |
| Software Verification ²³ 4343SWVERY | 500 | 6 |
| Sports Data Science ¹⁹ 4343SPDSCY | 500 | 6 |
| System and Software Security 4343SYSSSY | 500 | 6 |
| Text Mining 4343TXTMNY | 500 | 6 |
| Urban Computing 4343URBC6Y | 500 | 6 |
| Video Games for Research 4383VGFR6Y | 500 | 6 |

A more comprehensive description, exemptions and more information on the full programme can be found [here](#).

9. Specialisation Computer Science and Education

9.1 Description (Course and Examination Regulations chapter 2)

The specialisation *Computer Science and Education* (EDU) is offered as a joint programme with the Leiden University Graduate School of Teaching (ICLON). It prepares students for a career as computer science (in Dutch: 'informatica') teacher. This programme leads up to the so-called "eerstegraads onderwijsbevoegdheid", qualifying the student to teach in Dutch upper secondary education.

9.2 Learning outcomes (Course and Examination Regulations art. 2.3)

In addition to general achievements, graduates of the MSc programme Computer Science with the specialisation Education have all qualifications necessary for teaching all years of secondary education and technical and vocational training (for 12–18 year-olds).

9.3 Programme (Course and Examination Regulations chapter 3)

The *Computer Science and Education* programme consists of:

- a Master's thesis research project in Computer Science of 30 EC, level 600 (including *Master Class*, written thesis and oral presentation) in one of the research groups of LIACS;
- at least 30 EC of level-400-500 specialisation courses and seminars in Computer Science (see list in Article 8.3) to be selected in correspondence with the Master's thesis research topic and including the mandatory course *Psychology of Programming* (level 500, 6 EC); and
- the *Education component* as described [here](#).

The *Computer Science component* of the programme will be followed during the first year of study, the *Education component* will be followed during the second year.

When the student has passed the *minor Education* (30 EC) during the BSc programme, the compulsory *Education component* is reduced by 30 EC. The remaining 30 EC can be used for both the *Computer Science and Education component* of the Master's programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

MSc Governance of Sustainability

CROHO-number 60965

1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc programme is instituted in the Faculty of Science of Leiden University, herein referred to as the Faculty, and taught in The Hague by the Institute of Public Administration and Leiden University College, Faculty of Governance and Global Affairs, and by the Institute of Environmental Sciences, Faculty of Science.

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Governance of Sustainability.

The goal of the master programme Governance of Sustainability is to provide students with a thorough basis in natural sciences and in governance needed to handle the grand challenges regarding sustainability. Students learn how to analyse these complex issues from both perspectives and how to integrate these perspectives in order to develop and improve the quality of governance solutions needed to converge to a sustainable society. In addition, you will acquire a variety of skills required to cope with sustainability problems and to develop oneself into a future 'change agent'.

1.1 Learning outcomes (Course and Examination Regulations art. 2.3)

Knowledge and understanding

The student has a thorough knowledge of:

1. The technical and scientific aspects of the key sustainability issues. These issues include among others materials and circular economy, biodiversity and ecosystems, climate and energy and toxicity and water.
2. The key concepts and theories that are relevant to understanding governance processes. These concepts and theories include among others institutions and policy cycles, decision making and governance networks, global governance and multi-level analysis and policy framing.

The student is able to:

3. Recognize normative and culture positions of all actors involved in the governance of sustainability – both academics and practitioners.
4. Select and apply a variety of social science and natural science methods to evaluate sustainability issues, such as Environmental Input-Output Analyses, Spatial analyses, Network, Stakeholder and Multi-level analyses.
5. Explain why sustainability issues are complex problems, starting from an integrated analysis of both the natural and the social sciences.
6. Understand how sustainability issues are constrained and enabled by multilevel and multi-stakeholder governance settings and policy processes.
7. Explain which theories, concepts, and data from the natural sciences is -or could be- applied in transnational, national and local governance processes.
8. Analyse a complex sustainability issue and combine knowledge and methods from various disciplines to come to an integrated proposal for governance solution for the issue at hand.

9. Formulate integrated and innovative solutions and implementation pathways regarding sustainability issues.

Skills

The student is able to:

10. Operate within a transdisciplinary and diverse international context.
11. Design and carry out in-depth research on sustainability issues, starting from a set of concepts, theories and research methods based on either the natural or the social sciences, or from a combined approach.
12. Execute integrative scientific research projects (design, organize, execute, analyse and report).
13. Convincingly communicate results from scientific research about sustainability issues to both specialist and non-specialist audiences.
14. Argue a well-considered stance on the governance of sustainability issues, making use of the relevant disciplines.
15. Recognise, respect and use individual and cultural differences within a team.

Judgement

A student is able to:

16. Make an integral and critical assessment of available scientific knowledge and knowledge about governance processes to make judgements about sustainability issues.
17. Compare different transnational, national and local governance settings, policy approaches and institutions to address sustainability issues and apply the most suitable approach.
18. Critically reflect on ethical and normative dimensions regarding the governance of sustainability issues and the associated questions of complexity and uncertainty.
19. Act according to the different normative and culture positions of all actors involved in the governance of sustainability.

Learning skills

A student:

20. Has a positive attitude and openness towards self-directed and life-long learning.
21. Is able to design and plan their own learning processes by virtue of continuous reflection on personal knowledge, skills, attitudes and performance.
22. Is able to study independently and explore new areas of interest regarding the governance of sustainability issues.

2. Admission to the programme (Course and Examination Regulations chapter 5)

The programme starts in September and has a second intake in February. Admission in September is however preferred. The two faculty boards will jointly appoint the Board of Admissions. The Board of Admissions consists of two members: one staff member from each faculty. The Board of Admissions will judge the qualifications of the applicants on the basis of their previous training.

2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission.

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.²⁹

2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act holders of one of the following degrees may be admitted to the programme:

- holders of a bachelor's degree from a research university in the Netherlands, or from a foreign research university of similar level.

2.2.2 The Board of Admissions may, on request, admit persons to the programme who do not hold a bachelor's degree from a research university in the Netherlands, or from a foreign research university of similar level, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of such a bachelor's degree, possibly under further conditions, without prejudice to the conditions specified below.

This may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in the Netherlands, or from a foreign University of Applied Sciences of similar level and length of studies. The hbo diploma has to be obtained with a grade point average of at least 7.5.

2.2.3 Dutch and English languages³⁰

2.2.3.1 As further clarification of Article 2.8 in the Faculty part of this master's Course and Examination Regulations concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

2.2.3.2 If a student who wishes to be admitted does not meet the abovementioned language requirements, at least one of the following language requirements can be set:

²⁹[Regulations for Admission to Master's Programmes](#)

³⁰ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- IELTS: minimum overall score of 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90 (minimum 20 component score)
- Cambridge C2 Proficiency (CPE) or C1 Advanced (CAE): a score of at least 180 (minimum 169 component score).

2.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

2.2.4 Qualitative admission requirements

2.2.4.1 In addition to the aforementioned requirements, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

- a. Demonstrable knowledge of environmental sustainability issues on an academic level. This knowledge can be demonstrated through, for instance, successfully completed (elective) courses, a minor, major, a (thesis) research project, internship or work experience.
- b. Demonstrable experience with inter- or trans-disciplinary education and research. This experience can be demonstrated through, for instance, successfully completed (elective) courses, a minor, major, a (thesis) research project, internship or work experience.
- c. Passed one or multiple courses that included a minimum of 8 EC of mathematics, programming and/or statistics.

Admission process

Applicants as referred to in Article 2.2.1 and 2.2.2. are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter which elaborates on the qualitative admission requirements specified above.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant meets the aforementioned qualitative requirements.

The deadline for the fulfilment of qualitative admission requirements mentioned above is before the start of the academic year in which the student starts the programme. However, applicants need to elaborate on the qualitative admission requirements in their letter when applying for the programme.

2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a Dutch or foreign research university with 1 to 15 ECTS of deficiencies may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1, the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

2.4 Bridging programmes (Pre-master's)

Not applicable.

3. Programme (Course and Examination Regulations chapter 3)

The programme consists of compulsory courses (78 EC), electives (12 EC) and a Research project (30 EC). The programme is outlined below.

| | Level | EC |
|--------------------------------------------------------------------------------|-------|----|
| First year | | |
| Transdisciplinary skills 4443TRADSY | 500 | 6 |
| Thematic course 1: Governance of Materials & Circular Economy 4443GMCECY | 500 | 12 |
| Thematic course 2: Governance of Biodiversity & Ecosystems 4443GBECOY | 500 | 12 |
| Thematic course 3: Governance of Climate change & Energy Transition 4443GCCETY | 500 | 12 |
| Qualitative Research skills 4443QUALRY | 500 | 6 |
| Thematic course 4: Governance of Water & Toxicity 4443GWTOXY | 500 | 12 |
| Second year | | |
| Quantitative Research skills 4443QUANRY | 500 | 6 |
| Sustainability Challenge 4443SUSCHY | 600 | 12 |
| Thesis Research Project 4443THRPRY | 600 | 30 |
| | | |
| Electives | | 12 |

3.1 Requirements second year

- To participate in the Sustainability Challenge and Quantitative Research skills, students need to have completed at least 48 EC of the first year MSc courses.
- To participate in the Thesis Research Project, students need to have completed at least 48 EC of the first year MSc courses and participated in the Qualitative and Quantitative Research skills courses.

3.2 Electives

Students have to complete at least 12 EC of electives. The electives have to be approved by the Board of Examiners before the start of the study components and must meet the following criteria:

1. The elective course should be on MSc level (similar to an MSc level at a Dutch research university);
2. The elective course should not show a (considerable) overlap with or replace compulsory courses or other chosen electives;
3. The elective course should:
 - a. Deepen the understanding in governance, or
 - b. Deepen the understanding in natural science aspects of sustainability, or
 - c. Improve non-transferable or transferable skills needed to become a knowledge broker or change agent, or
 - d. Gather topical knowledge on the masters' thesis research.
4. An elective course cannot be more than 12 EC. The total EC of electives may however exceed 12 EC.

3.2 Compulsory and optional components

- If a large difference exists between the expected and actual enrolment of students in a mandatory component, the programme management can decide to change the format of teaching methods and assessment.
- If a large difference exists between the expected and actual enrolment of students in a non-mandatory, elective component, the institute's board that offers this elective component may decide not to offer this component or to offer it in a different form; in this case, students will be informed before the start of the component and will be offered an alternative.

3.3 Capita Selecta

A capita selecta is an additional piece of work which is not covered by any other (elective) courses or part of the programme. A capita selecta can be proposed by a student, or by a scientific staff member. It can be conducted individually (by one student), or by a group of students. Within Governance of Sustainability a capita selecta can have the value of 2, 3, 4, 5 or 6 EC. All capita selecta's need to be approved by the Board of Examiners and graded by a GofS core examiner. If approved by the Board of Examiners, a capita selecta can be used as part of the 12 EC elective space.

3.4 Validity of interim examinations

The validity period of a partial grade is limited until the end of the academic year in which the interim examination was obtained.

MSc ICT in Business and the Public Sector

CROHO-number 60205

1. Description of the programme (Course and Examination Regulations chapter 2)

The MSc *ICT in Business and the Public Sector* is offered by the Leiden Institute of Advanced Computer Science (LIACS) as a two-year research master on the management and application of ICT in an organizational context.

Over the last years, rapid changes in information and communication technology (ICT) have created major challenges and opportunities for all kinds of organisations, industries, and individuals. To thrive in our modern information society, businesses and governmental organisations alike must combine a solid grasp of the evolving technological possibilities with a deep understanding of how to apply effectively and responsibly these in an organisational context.

1.1 Objectives of the programme (Course and Examination Regulations art 2.1)

The MSc *ICT in Business and the Public Sector* aims at providing a deeper understanding of the issues, challenges and opportunities in this area, with a specific focus on the management and alignment of ICT in a business and/or governmental context. The programme builds on a technical foundation of Computer Science that students bring from their bachelor's education.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc *ICT in Business and the Public Sector* offers the following two specialisations:

- ICT in Business
- ICT in the Public Sector

The specialisations *Science, Business, and Innovation*, *Science Communication and Society*, and *Education* are not available to students of the MSc *ICT in Business and the Public Sector*.

1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the master programme *ICT in Business and the Public Sector* have attained the following general learning outcomes:

- a. theoretical and practical skills in more than one specialist area of business, management and information and communication technology such that they can carry out research under overall supervision;
- b. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- c. the ability to interrelate and integrate various areas of management and information and communication technology;
- d. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a conference or as (part of) a scientific publication;
- e. sufficient understanding of the social and societal role of ICT in an organizational context to be able to reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;

- f. have the learning skills to allow one to continue to study in a manner that is largely self-directed or autonomous.

Graduates with the specialisation *ICT in Business* have obtained in-depth knowledge on how ICT enables innovations in all business areas including marketing, operations, finance, strategy and IT itself, and have developed practical skills and experience in applying these concepts in the context of private organisations. Graduates with the specialisation *ICT in the Public Sector* have obtained in-depth knowledge on areas relevant in the public domain such as politico-administrative relations, European procurement, and data-driven policy development, and have developed practical skills and experience in applying these concepts on an administrative and managerial level.

1.4 Programme duration and completion (Course and Examination Regulations art. 2.5)

The duration of the programme, is two years (120 EC). Courses can be organised on campus in Leiden as well as in The Hague. Students who complete the programme receive the degree Master of Science in ICT in Business and the Public Sector, with a description of the specialisation.

1.5 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February. However, they are strongly encouraged to start in September when most of the compulsory courses are scheduled.

1.6 Language of the programme (Course and Examination Regulations art. 2.8)

The programme is taught entirely in English.

2. Programme (Course and Examination Regulations chapter 3)

The programme is 120 EC in extent and consists of several course-work modules for a total of 82 EC, and a master's thesis research project of 38 EC. The research project should be supervised by at least one LIACS scientific staff member (or by a supervisor approved by the Board of Examiners) and can be an in-company project. The course-work modules cover methodological issues, foundational and advanced business-related topics, and foundational and advanced ICT related topics. Elective courses on ICT, business and governmental topics allow students to individualise their programme and accommodate their specific interests. In addition, there are possibilities to customise the programme through international exchange programmes.

Curriculum outline ICT in Business and the Public Sector

The curriculum depends on the student's background. Students with a business background follow the *foundation courses on ICT* (15 EC total). Students with an ICT background follow the *foundation courses on Business* (15 EC total). Students with a bachelor degree '*Informatica & Economie*' from Leiden University are exempted from the courses in the foundation modules. These students follow additional electives instead for 15 EC. Students who choose for the specialisation *ICT in Business* need to take all courses from the *Module specialisation ICT in Business* (24 EC in total), whereas students who choose for the specialisation *ICT in the Public Sector* take all courses from the *Module specialisation ICT in the Public Sector* (24 EC in total).

| Main courses | EC | LEVEL |
|-----------------------------------------|-----------|--------------|
| Advances in Data Mining 4343ADVDM | 6 | 500 |
| Applied Research Methodology 4353APRM4Y | 4 | 500 |

| | | |
|--------------------------------------------------------------------------------------|------------|------|
| Capstone Cases ³¹ 4353CSC4VY | 4 | 500 |
| Global Business game 4353GBGR1Y | 1 | 400 |
| ICT Architectures 4353ICTA6Y | 6 | 500 |
| ICT Enabled Process Innovation 4353ICTP3Y | 3 | 500 |
| Leading and Managing People 4603BSLM5 | 5 | 500 |
| Research Methods 4603BSRM5 | 5 | 500 |
| Software Development and Product Management 4353SWDPMY | 6 | 500 |
| Systems Development 4353SYSD3Y | 3 | 500 |
| Training Cross Cultural Management | 0 | n.a. |
| <i>Module Foundation Business or Module Foundation ICT (see below)</i> | 15 | 500 |
| <i>Module specialisation ICT in Business or ICT in the Public Sector (see below)</i> | 24 | 500 |
| Master Thesis Research Project 4353MRI38Y | 38 | 600 |
| Total | 120 | |

| Module Foundation Business | EC | LEVEL |
|------------------------------------|-----------|--------------|
| Accounting 4603BSAC3Y | 3 | 500 |
| Marketing Science 4603BSMK3Y | 3 | 500 |
| Operations Management 4603BSOM4Y | 4 | 500 |
| Strategy and Technology 4603BSSATY | 5 | 500 |
| Total | 15 | |

| Module Foundation ICT | EC | LEVEL |
|--------------------------------------------|-----------|--------------|
| Business Intelligence 4353BUSI3Y | 3 | 500 |
| Cyber Security 4353SYBSCY | 3 | 500 |
| Foundations of Software Testing 4343FSWT6Y | 6 | 500 |
| Process Modelling 4353PROMOY | 3 | 500 |
| Total | 15 | |

| Module specialisation ICT in Business | EC | LEVEL |
|---------------------------------------------------------|-----------|--------------|
| AI for Strategy ³² 4603BSAS3Y | 3 | 500 |
| Entrepreneurship 4603BSEN3 | 3 | 500 |
| Managing Software Evolution ³² 4353MNSE3Y | 3 | 500 |
| Strategic Financial Management ³³ 4603BSSF3Y | 3 | 500 |
| Systems Optimisation 4603BSSO3Y | 3 | 500 |
| <i>Electives (see below)</i> ³³³ | 9 | 500 |
| Total | 24 | |

³¹ As of September 2020 the course *Capstone Cases* is 4 EC worth (it was 3 EC). Students who have followed a previous version of this course before September 2020 but have not yet passed it, can still get 4 EC (instead of 3 EC) under the condition that they take the extra two *Consultancy classes* that will be organized in the new *Capstone Case* course. Arrangements for this needs to be made via the programme coordinator.

³² Students who started before 1 September 2021 and have already successfully completed the previously mandatory courses *Managing Innovation* or *Managing the Digital Business*, do not need to follow *Managing Software Evolution* or *AI for Strategy*.

³³ Students with a bachelor degree '*Informatica & Economie*' from Leiden University are exempted from this course and follow within this module 3 extra EC as elective courses instead of 9 EC.

| Module specialisation ICT in the Public Sector | EC | LEVEL |
|-------------------------------------------------------|-----------|--------------|
| Data-Driven Policy Making 4353DDPM3Y | 3 | 500 |
| Digital Government Citizen Interaction 4353DGCI3Y | 3 | 500 |
| Role of IT in Public Administration 4353RITPAY | 6 | 500 |
| Working for the Government as ICT Expert 4353WGICTY | 6 | 500 |
| <i>Electives (see below)</i> | 6 | 500 |
| Total | 24 | |

| Electives | EC | LEVEL |
|---------------------------------------------------|-----------|--------------|
| Data Science in Practice 4343DASPRY | 6 | 500 |
| Digital Transformations 4603BSDT5 | 5 | 500 |
| Entrepreneurial Finance 4603BSEF3Y | 3 | 500 |
| Information Retrieval 4343INFREY | 6 | 500 |
| Introduction to Machine Learning 4343INTMLY | 6 | 500 |
| Lean Six Sigma 4603BSLS3Y | 3 | 500 |
| Management Science 4603BSMS3Y | 3 | 500 |
| Managing Software Evolution 4353MNSE3Y | 3 | 500 |
| Marketing Analytics 4603BSMAAY | 3 | 500 |
| Regulatory Governance and Data Science 4353RGDS6Y | 6 | 500 |
| Social Network Analysis ? | 6 | 500 |
| System and Software Security 4343SYSSSY | 6 | 500 |

Students that wish to take other electives than those listed above need to submit their course selection to the Board of Examiners.

2.1 Transitional arrangements

Post Experience

As of 2019-2020, the *Post Experience* programme (for candidates with working experience) is no longer offered. Current *Post Experience* students (starting September 2017 and earlier) will be enabled to finish their studies.

Course renaming

As of September 1st, 2021, the following courses have been renamed: *Strategy and Technology* (was *Strategy*), *Marketing Science* (was *Marketing*), *Strategic Financial Management* (was *Financial Management*), and *Operations Management* (was *Technology Operations Management*). Previously completed courses are considered equivalent to those renamed in September 2021.

3. Admission to the programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the

Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.³⁴

3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Computer Science (Informatica) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a computer science-related programme from a research university in the Netherlands or from a foreign research university of similar level provided that the candidate has accumulated at least 90 EC (or the equivalence thereof) in courses/projects belonging to the domain of Computer Science (including knowledge of programming and software engineering skills).
- c. Holders of a bachelor's degree and additionally having passed the prescribed pre-master's programme pursuant to Article 3.4.1

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions.

Article 3.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in computer science or business information science-related programmes. As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5.

Admission procedure

Applicants as referred to in Article 3.2.1.b and Article 3.2.2 are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1.a.

3.2.3 Dutch and English languages³⁵

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An [International Baccalaureate](#) diploma (with English A);

³⁴[Regulations for Admission to Master's Programmes](#)

³⁵ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

3.2.4 Qualitative admission requirements

Not applicable.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1, the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

3.4.1 The department has developed the following bridging programmes in order to remove deficiencies:

- For students with bachelor's degrees related to Computer Science the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.
- A lack of (Python) programming and Software Engineering skills will need to be addressed in the bridging programme.

3.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

MSc Life Science and Technology

CROHO-number 66286

1. Description of the programme (Course and Examination Regulations chapter 2)

The Leiden Institute of Chemistry (LIC) forms the basis for research and collaborations of the Leiden chemistry and life sciences groups. The LIC offers two MSc programmes, namely the MSc Life Science and Technology and the MSc Chemistry. The programme Life Science and Technology concerns the study and manipulation of processes occurring in the living cell. The cell is the building block of life; it is the smallest unit with the characteristics of living systems. Increased knowledge of the mechanisms of processes in the cell can lead to better medicines or new methods for combating diseases. The MSc programme LST fits within the Leiden University research profiling theme of “BioScience: Science base of Health”.

Research topics in *Life Science and Technology* within the LIC comprise chemical and biomolecular synthesis and design combined with cell and chemical biology research. Thereby an unprecedented foundation is created for understanding the fundamental cellular processes and mechanisms underlying diseases, as well as knowledge of and skills in the technology to manipulate these systems for therapeutic purposes. At the core of our modern understanding of health and disease are studies on protein-protein interactions, synthesis and manipulation of protein structures, the use of novel chemical probes and inhibitors, the study of the effects of these potential drugs in cells and application of bio(medical) informatics. Our MSc students specifically learn to understand the molecular and structural chemical and biological aspects of disease-related processes and will be able to apply chemical and biotechnological tools to the treatment of diseases. The molecular insight of MSc LST students is highly appreciated by research groups in institutes such as LUMC and ErasmusMC and in research institutes abroad.

A variety of molecularly based, disease-related research training projects can be carried out at the LIC or alternatively at LACDR, IBL, LUMC, the Dutch Cancer Institute (NKI) or ErasmusMC. Detailed information concerning the LST-related research topics that are investigated at the LIC can be found on the websites of the research groups, via <https://www.universiteitleiden.nl/en/science/chemistry/>.

1.1. Specialisations (Course and Examination Regulations art. 2.2)

The MSc LST programme offers four specialisations: Life Science Research and Development (RESEARCH), Life Science and Business Studies (BS), Life Science and Science Communication and Society (SCS) and Life Science and Education (EDU). The duration of each specialisation is two years (120 EC); a general programme overview of the four specialisations is given in Table 1. Students who complete the programme receive the degree Master of Science in LST, with specification of the specialisation.

Table 1: Overview of the programmes of the four MSc LST specialisations (weights in EC)

| Specialisation | RESEARCH | EDU** | SCS | BS |
|-------------------------------|----------|---------|-----|----|
| Research Training | 60 | 30 / 40 | 30 | 30 |
| Academic Skills | 6 | 6 | 6 | 6 |
| Core courses in research area | 24 | 24 | 24 | 24 |
| Essay & Colloquium | 6 | - | - | - |
| Free electives* | 24 | 0 / 20 | 20 | 20 |
| EDU/SCS/BS components | - | 60 / 30 | 40 | 40 |

| | | | | |
|-----------------|------------|------------|------------|------------|
| Total EC | 120 | 120 | 120 | 120 |
|-----------------|------------|------------|------------|------------|

* The choice in the free electives is restricted to the boundaries specified in this document. A maximum of 20 EC can be used for extension of the research training. A maximum of 20 EC may be used as an extension of the SCS or BS components.

** If the student has taken a minor in Education (“tweedegraadsbevoegdheid”) of 30 EC in the BSc programme, only 30 EC are necessary in the MSc programme to obtain the “eerstegraadsbevoegdheid”; then 30 EC electives are added to the programme of the MSc LST, of which at least 10 EC should be used for research training within the boundaries specified in sections 4.3 and 7.3.

1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

After completion of the MSc LST programme students will have developed:

- Knowledge and understanding of theoretical concepts of Life Sciences from textbooks and primary literature pertaining to the research area
- The ability to plan chemical research, perform experiments within an appropriate time frame, collect and store data in a logical way, such that colleagues can easily find and access the data (data management)
- The ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, and formulate verifiable hypotheses
- An appropriate critical scientific attitude, i.e. the ability to analyse results and critically evaluate their validity and accuracy
- The skill to communicate Life Sciences research progress and results to colleagues, supervisors and experts
- The ability to write independently a structured and accurate report on performed research in Life Sciences
- The ability to perform with an academic attitude and the skills for autonomous self-development, taking into account the ethical and social aspects of the natural sciences.

1.3 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February; international students are strongly advised to start in September.

1.4 Programme organisation

All specialisations have the same Programme Director and the same Board of Admissions. The Programme Committee for the MSc programme LST is combined with the one for the MSc programme Chemistry and is responsible for the Research specialisation and the programme-specific components of the other specialisations. The specialisation-specific components of the BS, EDU and SCS specialisations have their own Programme Committees. The Board of Examiners of the MSc programme LST is also combined with the one of the MSc programme Chemistry. In addition, the specialisations BS, SCS and EDU each have their own faculty-wide Board of Examiners appointed by the Faculty of Science for the specialisation-specific part of the MSc programme.

All MSc students are guided by a personal mentor. The mentor generally is the supervisor of the major research training project. The mentor will coach the student from the admission throughout the MSc programme to the final examination. The study adviser can advise the student concerning scheduling and planning of the programme. A web-based master planner is used for planning and registration of the study programme, and is to be filled in by the student in consult with the mentor. The mentor and student discuss the progress of the student at least every six months using the results documented in the master planner. The master planner is updated by the student on a regular basis. It is accessible to the student, the mentor, the study coordinator and the study adviser.

The study adviser will mediate when a student encounters problems in the interaction with the mentor.

2. Programme (Course and Examination Regulations chapter 3)

Students compose their own study programme (choice in core courses, electives and research training project) in consent with their mentor, who is a scientific staff member of the LIC. The choice in elective courses in the MSc programme may be limited by the need to adapt the programme to the present knowledge of the candidate. The programme may be adjusted during the course of the MSc study.

Specialisation-specific components of the specialisations Life Science and Business Studies, Life Science and Science Communication and Society, and Life Science and Education are described separately in this Appendix. A double specialisation should comprise a full programme of one specialisation (i.e. the main specialisation) plus the specialisation-specific components of a second specialisation. The main specialisation should be chosen in the following order: Research above Education above Business/Communication. The number of credits for double specialisations thus must be at least 150 EC (Research + EDU-30), 160 EC (Research + BS; Research + SCS; EDU + BS, EDU + SCS, BS + SCS) or 180 EC (Research + EDU-60).

3. Admission to the Programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.³⁶

3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree in Life Science and Technology (LST) from any research university in the Netherlands, or
- b) holders of a bachelor's degree in an LST-related programme from a research university in the Netherlands or from a foreign research university of equal level, provided that the candidate has:
 - accumulated at least 150 EC (or the equivalence thereof) in courses/projects belonging to the domain of Life Science and Technology and
 - obtained the degree with an average final grade of at least 7.0 (Dutch grading system) and

³⁶ [Regulations for Admission to Master's Programmes](#)

- a research project/internship grade of at least 7.5 such to be judged by the Board of Admissions.

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in Article 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1, subsections a and b, without prejudice to the qualitative conditions specified in Article 3.2.4.

Article 3.2.2 may, amongst others, apply to holders of a degree from a foreign research university that does not meet the requirements specified in Article 3.2.1 subsection b or to a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo) in an LST-related programme provided that the candidate has:

- obtained the degree with an average final grade of at least 7.5 (Dutch grading system) and
- a research project/internship grade of at least 8.0

Admission process

Applicants as referred to in Article 3.2.1.b and Article 3.2.2 are requested to provide the Board of Admissions with the following:

- Copies of diploma(s) and transcript(s) of grades,
- A placement letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in Article 3.2.1 subsection a,
- A curriculum vitae,
- Letter of recommendation by the internship supervisor (group or team leader),
- Hbo students as referred to in Article 3.2.2 should also submit a letter of recommendation of the mentor ('studieloopbaanbegeleider') of the BAS programme.

3.2.3 Dutch and English languages³⁷

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in the Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

³⁷ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

- IELTS: minimum 6.5 (minimum score on each subtest: 6.0)
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Advanced.

3.2.4 Qualitative admission requirements

Not applicable.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in Article 3.2.1 subsections a and b, or an equivalent diploma with a maximum of 15 EC of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in Article 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in Article 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of Article 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

Not applicable.

4. Specialisation Life Science Research and Development (RESEARCH)

4.1 Description (Course and Examination Regulations chapter 2)

The research specialisation offers the student the opportunity to spend two full years on training and specialisation not only to become an independent and creative researcher, but also someone who can use their analytical skills to resolve challenges in their career in science or in society. The majority of the students with an MSc in Research in LST will continue their career in a PhD position.

4.2 Programme (Course and Examination Regulations chapter 3)

The Life Science research and development programme (RESEARCH) consists of the parts specified in Table 2.

Table 2: Overview of the programme Life Science research and development

| Catalogue number | Component | Study load | Level |
|------------------|-----------------------------------|------------|---------|
| | Research training: | 60-80 EC* | 600 |
| | Major research project | 40-60 EC | 600 |
| | Minor research project (optional) | 20-40 EC | 600 |
| 4603SCMT4 | Science Methodology | 4 EC | 400 |
| 4423ACWR2 | Academic Writing | 2 EC | 400 |
| 4423ESCOL | Essay and colloquium | 6 EC | 500 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 24 EC | 400-600 |

* The total weight of research projects may not exceed 80 EC.

4.3 Research Training

4.3.1 Scope and study load: The research training is carried out within a LIC research group, at the LACDR, or at the IBL. Our MSc students also have the opportunity to carry out pre-clinical master research training projects in biomedical research institutes, including the LUMC, NKI or ErasmusMC. The research training may be split into a major and one or more minor projects. The major research project is limited to a minimum of 40 EC and a maximum of 60 EC; an optional minor research project must comprise at least 20 EC. A minor research training project can be carried out in another research group, another institute (within the Netherlands or abroad) or in industry. Prior approval of the Board of Examiners is required for a research project outside the LIC, IBL, LACDR, LUMC, NKI, or ErasmusMC.

4.3.2 Supervision and evaluation: Each research training project must be supervised by a scientific staff member (main supervisor). Major research projects are evaluated and graded by at least the main supervisor and two Thesis Talk jury members. These Thesis Talk jury members are staff members who were not directly involved in the research project. They judge the quality of the research report, the quality of the presentation and the scientific level of the student and decide the final grade together with the main supervisor. Minor research projects carried out within the LIC are evaluated and graded by two LIC scientific staff members who were not the main supervisor for the major research training project. External research training projects are supported, evaluated and graded by a scientific staff member of the LIC who was not the main supervisor for any other research training project (the internal supervisor) and a staff member from the host institute (the external supervisor). The internal supervisor has the final responsibility for creating the research project agreement, grading the research project report and creating, signing and submitting the project evaluation form.

4.3.3 Written report: All research training projects are concluded with a written report; for the major research training this is the MSc thesis. The requirements for the written report are specified in the Prospectus. The final version of the report should be handed in within 3 months after the last day of practical work.

4.3.4 Thesis Talk: The major research project is concluded with an oral presentation for the main supervisor, the Thesis Talk jury members, the external supervisor (if applicable) and an audience of interested students and staff members of the LIC (i.e. Thesis Talk). Students should attend at least 7 Thesis Talks as part of their major research project.

4.3.5 Obligatory sequence (Course and Examination Regulations art. 4.2): Students can only start with an optional minor research training project (within or outside the LIC) when the major project has been successfully concluded with a grade (including a Thesis Talk). Exceptions can only be granted by the Board of Examiners following article 4.2.2 of the Faculty OER.

4.4 Theoretical compulsory components

The compulsory theoretical component comprises a selection of four core courses, courses on academic skills (Science Methodology and Academic Writing) and a literature essay with a colloquium.

The colloquium supervisor cannot be the main supervisor of any of the student's research projects. The final grade for the colloquium is determined by a colloquium jury composed of two LIC staff members. The jury cannot include the colloquium supervisor or the main supervisor of any research project. Students should attend at least 7 colloquia as part of their own colloquium and essay component.

The four core courses are chosen from the list described in Table 3. The LST master students have to choose one course from each of the series (Biomedical, Molecular and Biophysical Sciences), plus one additional course from one of the three series.

Table 3: Core courses in the MSc Life Science and Technology. All courses encompass 6 EC.*

| Course title | Level | Catalogue number |
|-------------------------------------------------------|-------|------------------|
| Biomedical Sciences | | |
| Biomedical Informatics | 500 | 4423BMINFY |
| In-vivo Biomolecular Interactions Underlying Diseases | 500 | 4423IVBIRY |
| Chemical Immunology | 500 | 4423CHEIMY |
| Molecular Sciences | | |
| Molecular Chemistry** | 400 | 4423MCHEMY |
| Chemical Biology | 500 | 4423CHEMBY |
| Metals and Life | 500 | 4423METL6Y |
| Biophysical Sciences | | |
| Bionanotechnology | 500 | 4423BIONTY |
| Enzyme Dynamics: NMR Spectroscopy and Kinetics | 500 | 4423EDNMRY |
| Biomaterials | 500 | 4423BIOMAY |

* Courses that were taken in the BSc programme cannot be taken again in the MSc programme.

** This course cannot be chosen in combination with the course Synthetic Organic Chemistry (SOC), or when SOC was taken in the BSc programme.

4.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK" (catalogue number 4423WORKV: "Career Orientation & Competence Reflection"). Students have to *Write* an application letter and CV, attend seminars and workshops for job market *Orientation*, and have to *Reflect* on their skills, strengths and weaknesses. After finalisation of this component they will have acquired improved *Knowledge* of what they are good at and what kind of career they would like to pursue! This component comprises a number of activities and workshops to create awareness of the job market and give students insight into their skills, abilities and weaknesses. During the two years of the MSc programme, a number of different activities are offered. The activities include alumni events (e.g. lectures, speed-dating), workshops offered by the Career Service, self-assessment and self-reflection tasks, participation in excursions to companies and visits to career fairs such as the 'β-banenmarkt'. All students have to do a self-evaluation test at the start of their programme, take

part in the workshop 'CV, LinkedIn profile and cover letter' during their studies, and write a self-reflection after their major research project. In addition, students take at least six of the workshops or other activities that are offered by the programme, Career Service or other partners during their studies, within the boundaries specified by the programme.

4.6 Electives

The electives can comprise either theoretical or practical courses or an extension of the duration of a research project with a maximum of 20 EC and within the limitations described in section 4.3. Elective courses can be chosen from the core courses within or outside the chosen research area, approved elective MSc courses of the Leiden University Faculty of Science published in the Prospectus, MSc courses offered in a Science Faculty of any Dutch or foreign university of level 400 or higher, level 400 courses from the BSc MST or LST programmes, or other relevant courses approved by the Board of Examiners on an individual basis. Elective courses are restricted to courses that were not part of the student's earlier studies and do not overlap in content with other courses already taken as part of the MSc curriculum.

Students can verify the suitability of their programme with the Board of Examiners when they have doubts about a combination of courses.

Students must gain approval from the Board of Examiners prior to taking any components offered by universities outside the Netherlands, as well as starting any research project outside the LIC, IBL, LACDR, LUMC, NKI or ErasmusMC.

5. Specialisation Life Science and Business Studies

5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Business Studies (BS) offers students the possibility to combine Life Science with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

5.2 Programme (Course and Examination Regulations chapter 3)

The Life Science and Business Studies (BS) programme consists of the parts specified in Table 4. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Table 4: Overview of the programme of the specialisation Life Science and Business Studies

| Catalogue number | Component | Study load | Level |
|----------------------|---------------------|-----------------|---------|
| | Research training | 30 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 0-20 EC | 400-600 |
| BS components | | | |
| | BS courses | 20 EC | 500 |
| | BS internship | 20, 30 or 40 EC | 600 |

BS electives

0-20 EC

400-500

5.3 Research Training

The research training project in LST should be carried out in one of the research groups of the Leiden Institute of Chemistry or other institutes as specified in section 4.3. It includes a written report (MSc thesis) and is finalised with a Thesis Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

5.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation and courses on academic skills (Science Methodology and Academic Writing).

5.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component “WORK”. See the description and specifications in section 4.5.

5.6 Elective components

Elective components may consist of additional courses within or outside the chosen research area, an extension of the research project, additional BS courses or an extension of the Business Internship. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

5.7 BS components

A minimum of 40 EC and a maximum of 60 EC within the BS component is required to complete the BS specialisation. A specification of the BS specialisation is described [here](#).

6. Specialisation Life Science and Science Communication and Society

6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Science Communication and Society (SCS) offers students the possibility to combine life sciences and science communication. Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

6.2 Programme (Course and Examination Regulations chapter 3)

The SCS programme consists of the parts specified in Table 5. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Students who complete the specialisation Life Science and Technology and Science Communication and Society are admissible to a PhD programme in Life Science and Technology or in Science Communication.

Table 5: Overview of the programme of specialisation Life Science and Science Communication and Society

| Catalogue number | Component | Study load | Level |
|------------------|-------------------|------------|-------|
| | Research training | 30 EC | 600 |

| | | | |
|-----------------------|----------------------------------------------|---------|---------|
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 0-20 EC | 400-600 |
| SCS components | | | |
| 4603SCISEY | Informal Science Education* | 4 | 400 |
| 4603SCPDSY | Policy & Development in science and Society* | 4 | 400 |
| 4603SCRSCY | Research in science communication* | 4 | 400 |
| 4603SCSJ4Y | Science Journalism (ENG)* | 4 | 400 |
| 4603SCSWJY | Wetenschapsjournalistiek (NL)* | 4 | 400 |
| 4603SCPRDY | Science Communication product development** | 4 | 400 |
| 4603SCNV3Y | SCS: Scientific Narration and Visualization* | 3 | 500 |
| | Internship | | |
| 4603SCSPPY | SCS Project Proposal | 3 | 600 |
| 4603SCSS1Y | SCS Internship(s) | 14-34 | 600 |
| | Additional elective | | |
| 4603SCSELY | SCS elective | 1-10 | 400-500 |

* *SCS courses* are available as elective course for students who don't follow the SCS specialisation.

** the course **Science Communication product development** is only admissible for students who have completed all other SCS courses.

6.3 Research Training Project

The research training project in LST should be carried out in one of the research groups of the Leiden Institute of Chemistry or other institutes as specified in section 4.3. It includes a written report (MSc thesis) and is finalised with a Thesis Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

6.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation and courses on academic skills (Science Methodology and Academic Writing).

6.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component "WORK". See the description and specifications in section 4.5.

6.6 Elective components

Elective components may consist of additional theoretical courses within or outside the chosen research area, an extension of the research project, additional SCS courses or an extension of or additional SCS internships. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

6.7 SCS components

A minimum of 40 EC and a maximum of 60 EC within the SCS component is required to complete the SCS specialisation. A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

7. Specialisation Life Science and Education (NL)

7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Life Science and Education (EDU) prepares students for a career as chemistry (scheikunde) or biology (biologie) teacher qualified to teach in Dutch secondary education.

7.2 Programme (Course and Examination Regulations chapter 3)

The Life Science and Education (EDU) programme consists of the parts specified in Table 6. All programme-specific components must be finished before the specialisation-specific Education components can be started. Exceptions to this obligatory sequence can only be granted by the Board of Examiners of the MSc programme LST. A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

Table 6: Overview of the programme of the specialisation Life Science and Education

| Catalogue number | Component | Study load | Level |
|------------------------------------------------------|-------------------------|------------|---------|
| 60 EC EDU programme | | | |
| | Research training | 30 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 0 EC | |
| EDU components | | | |
| | EDU theoretical courses | 28 EC | 300-600 |
| | EDU teaching practice | 32 EC | |
| 30 EC EDU programme | | | |
| | Research training | 40 EC | 600 |
| 4603SCMT4Y | Science Methodology | 4 EC | 400 |
| 4423ACWR2Y | Academic Writing | 2 EC | 400 |
| | Core courses | 24 EC | 400-500 |
| | Electives | 20 EC | 400-600 |
| EDU components ('eerstegraads' only, see 7.6) | | | |
| | EDU theoretical courses | 15 EC | 400-600 |
| | EDU teaching practice | 15 EC | |

7.3 Research Training Project

The research training project in LST should be carried out in one of the research groups of the Leiden Institute of Chemistry or other institutes as specified in section 4.3. It includes a written report (MSc thesis) and is finalised with a Thesis Talk. Students should attend at least 7 Thesis Talks. The requirements for the research training are as specified in section 4.3 with the exception that the minimum length of the major research training project is 30 EC instead of 40 EC.

7.4 Theoretical compulsory components

The compulsory theoretical component comprises four core courses to be selected from Table 3 as described in the research specialisation and courses on academic skills (Science Methodology and Academic Writing).

7.5 Compulsory co-curricular component

Students have to take the compulsory co-curricular component “WORK”. See the description and specifications in section 4.5.

7.6 Elective components

When the student has passed the minor Education (30 EC) during their BSc programme, the compulsory Education component is reduced with 30 EC. The remaining 30 EC are added to the LST programme as electives, of which a minimum of 10 EC should be used for research training. Further elective components may consist of additional theoretical courses or further extension of the research project. Furthermore, the restrictions and conditions specified for electives in section 4.6 apply.

7.7 EDU components

To complete the EDU specialisation, 60 EC within the EDU component is required. If a minor EDU was successfully taken in the BSc programme, the EDU component is limited to 30 EC. A specification of the EDU specialisation is described [here](#).

8. Transitional arrangements

8.1 The programme component Academic Skills is compulsory for students who started with the MSc Life Science and Technology per September 2017 or later. Students who do not have this obligation add 6 EC to their free electives and are allowed to take the courses associated with the Academic Skills component as electives.

8.2 If a student has demonstrable prior knowledge of one or both subjects of the compulsory courses in the programme component Academic Skills, they can request permission from the Board of Examiners for an alternative set of courses to fill the Academic Skills component. The Academic Skills component should encompass at least 6 EC, should be in the broad subject area of academic skills and is bound to the same requirements as stipulated for elective courses in section 4.6.

8.3 The compulsory co-curricular component “WORK” is not required for students who started before September 2019.

8.4 Students who started before September 2019 must attend at least 10 Thesis Talks, unless they voluntarily take the co-curricular component ‘WORK’, in which case they must attend at least 7 Thesis Talks.

8.5 Students who started before September 2019 and choose the research specialisation must attend at least 10 colloquia, unless they voluntarily take the co-curricular component ‘WORK’, in which case they must attend at least 7 colloquia.

8.6 Students who started before September 2020 in the EDU-30 programme are not required to use at least 10 EC of their electives to extend the research training component of the programme.

8.7 Students are allowed to compose their set of core courses for the final examination based on the set described in either the current OER or the applicable OER at the time they started their MSc programme, provided they did not interrupt their registration.

8.8 In addition to article 8.6, students who started per February 2019 and base their core courses on the set described in the OER 2018-19 are allowed to take Metals and Life (4423METL6) as a core course in the set 'Molecular Sciences'.

8.9 After discontinuation of a component or major changes to a component, the student is provided with one more option to finish the component in the following academic year, where applicable via partial exams and/or compensatory assignments.

8.10 When a student does not use the opportunity mentioned in 8.9 or does not acquire a pass grade, the student is required to replace the missing ECs with another component following the requirements for their specialisation.

8.11 If a student for any reason, including the situation stipulated in 8.9 and 8.10, is not able to compose a programme conform the requirements, the Board of Examiners can grant an exception and approve an alternative programme. The Board of Examiners judges whether the alternative programme guarantees the student meets the learning outcomes of the programme.

MSc Mathematics

CROHO-number 66980

1. Description of the programme (Course and Examination Regulations chapter 2)

The programme is taught in Leiden by the Mathematisch Instituut (MI).

The duration of each programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Mathematics, with specification of the specialisation, if applicable. Details are provided below. All specialisations have the same Director, the same Board of Examiners, and the same Department Teaching Committee. A Board of Admissions will advise on admissions. Exceptions to this are formed by the specialisations Business Studies (BS), Science Communication and Society (SCS), and Education (EDU) which for the specialisation-specific part each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The goal of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance their career.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The Universiteit Leiden offers five specialisations of an MSc programme in mathematics. Two of these correspond to research specialisations in the Leiden Mathematisch Instituut. The remaining three specialisations combine research in mathematics with Business Studies, Science Communication and Society, and Education.

1.3 Final qualifications/ final learning outcomes (Course and Examination Regulations art. 2.3)

Generic, for all specialisations

A *Knowledge and Understanding, and their Application*

Master graduates have:

- A1 knowledge and understanding of the core concepts and principles of the broad mathematics domain, and have thorough knowledge and understanding of at least one subdomain of mathematics which is related to one of the following topics:
 - for the specialisation Algebra, Geometry and Number Theory: algebra, algebraic and analytic number theory, algebraic and differential geometry, topology, cryptology, or combinatorics;
 - for the specialization Applied Mathematics: differential equations, dynamical systems, analysis of problems from industry and the life sciences, measure and integration theory, probability theory, statistics, functional analysis, numerical analysis, or operations research;
- A2 proficient skills in applying mathematical theory to concrete mathematical problems;

- A3 the ability to recognise the specific mathematical areas relevant to a problem;
- A4 the ability, under supervision, to either formulate a research question in a mathematically rigorous way, and to set up and carry out the subsequent analysis of the problem; or, to study a topic of recent research and to provide an original exposition exhibiting deep understanding of the material.

B Making Judgements

Master graduates are able to:

- B1 independently interpret and reflect on mathematical results;
- B2 act as professional academics with a sound ethical attitude, and they are aware of the societal role of a professional mathematician with a corresponding level of integrity and the according behaviour.

C Communication

- C1 Master graduates are able to write a clear and unambiguous scientific report, and to communicate orally with mathematicians and non-specialists.

D Learning Skills

Master graduates have:

- D1 the ability to acquire and integrate new [/additional] knowledge relevant to a mathematical problem;
- D2 sufficient mathematical knowledge and academic and general professional skills to become productive in industry, government, as a high school teacher, or as a PhD student in mathematics.

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Starting the programme is possible throughout the year, but international students are strongly advised to start in September or February.

2. Admission to the programme (Course and Examination Regulations chapter 5)

2.1 Confirmation of admission

2.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 2.2 and 2.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 2.2.1, the proof of registration is also confirmation of admission .

2.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.³⁸

2.2 Admission to the programme

2.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Mathematics (Wiskunde) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a mathematics-related programme from a research university in the Netherlands or from a foreign research university of similar level, or in a related sciences programme, provided the candidate has accumulated the mathematical background at least equivalent to a bachelor's degree in mathematics.

2.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 2.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 2.2.1, sub-sections a and b, possibly under further conditions.

Admission process

Applicants as referred to in Article 2.2.1. b and Article 2.2.2. are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1 a.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 2.2.1.a.

2.2.3 Dutch and English languages³⁹

2.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An International Baccalaureate diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

³⁸[Regulations for Admission to Master's Programmes](#)

³⁹ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

2.2.3.2 If a student who wishes to be admitted does not meet the requirements in 2.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: : internet based 90, with a minimum of 20 on each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

2.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Gevorderd.

2.2.4 Qualitative admission requirements

Not applicable.

2.3 Deficiencies

2.3.1 Holders of a bachelor's degree from a research university, referred to in 2.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

2.3.2 Students who still have the deficiencies referred to in 2.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

2.3.3 For the admission referred to in 2.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

2.3.4 If a student is admitted to the programme on the basis of 2.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

2.4 Bridging programmes (Pre-master's)

Not applicable.

3. Specialisation Algebra, Geometry and Number Theory (ALGANT)

3.1 Description (Course and Examination Regulations chapter 2)

The MSc programme Algebra, Geometry and Number Theory leads students to a high level of knowledge in this area. It consists of advanced courses from the field and a final research project including a master thesis and an oral presentation of it. Students with this MSc in Mathematics are admissible to a PhD programme. The programme is suited as preparation for an academic career, in

particular via a subsequent PhD study, but also for a career as mathematical researcher outside the universities.

3.2 Programme (Course and Examination Regulations chapter 3)

For each student a programme will be tailored individually. It consists of

- a choice of at least 60 EC of advanced courses (at least 30 EC of these must be obtained via courses of Mastermath, the Dutch Master Programme in Mathematics) from algebra, algebraic and analytic number theory, algebraic and differential geometry, topology, cryptology, combinatorics, or related subjects, if agreed in advance with the study advisor of this specialisation;
- a research project in Mathematics of 40 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- a free choice of courses from any field as agreed with the study advisor, of maximally 20 EC.

Required is a total of at least 120 EC.

4. Specialisation Applied Mathematics

4.1 Description (Course and Examination Regulations chapter 2)

The MSc programme Applied Mathematics leads students to a high level of knowledge in this area. It consists of advanced courses from the field and a final research project including a master thesis and an oral presentation of it. Students with this MSc in Mathematics are admissible to a PhD programme. The programme is particularly suited as preparation for a career as mathematical researcher in industry, government and other institutions, but also for an academic career, in particular via a subsequent PhD-study.

4.2 Programme (Course and Examination Regulations chapter 3)

For each student a programme will be tailored individually. It consists of

- a choice of at least 60 EC of advanced courses (at least 30 EC of these must be obtained via courses of Mastermath, the Dutch Master Programme in Mathematics) from differential equations, dynamical systems, analysis of industrial problems, measure- and integration theory, probability theory, statistics, functional analysis, numerical analysis, operations research or related subjects, if agreed in advance with the study advisor of this specialisation;
- a research project in Mathematics of 40 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- a free choice of courses from any field as agreed with the study advisor, of maximally 20 EC.

Required is a total of at least 120 EC.

5. Specialisation Business Studies

5.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Business Studies (BS) offers students the possibility to combine mathematics with knowledge, insights and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form an opinion on and prepare for a career in industry and to enhance competences for pursuing entrepreneurial business opportunities created in science and research.

Students who complete the specialisation Mathematics and Business Studies are admissible to a PhD programme.

5.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Business Studies programme consists of:

- a research project in Mathematics⁴⁰ of 20 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- 40 EC of courses to be selected in correspondence with the research topic;
- a maximum of 20 EC of electives within either Mathematics or the Business Studies component.

Completion of the specialisation Business Studies requires a minimum of 40 EC and a maximum of 60 EC within the Business Studies component. Required is a total of at least 120 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

Students who started the master programme in 2019-2020 have the choice to follow the old programme consisting of a research project in Mathematics of 30 EC, with 30 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

6. Specialisation Science Communication and Society

6.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Science Communication and Society (SCS) offers students the possibility to combine mathematics and science communication.

Students are prepared for a career in popularisation of science or for a career as a scientist with a communicating mind-set.

⁴⁰ For the programme Mathematics and Business Studies the BS internship should be connected to the research project in Mathematics.

Students who complete the specialisation Mathematics and Science Communication and Society are admissible to a PhD programme in mathematics or in science communication.

6.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Science Communication and Society (SCS) programme consists of:

- a research project in Mathematics of minimally 20 EC (including a master's thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- minimally 30 EC of courses to be selected in correspondence with the research topic, summing up to a total of at least 60 EC for these courses and the research project; and
- a maximum of 20 EC of electives within either Mathematics or the SCS component; and
- The Science Communication and Society programme consists of the parts specified as follows:

| | Level | EC | Catalog nr |
|------------------------------------------------|---------|-------|------------|
| • Informal Science Education* | 400 | 4 | 4603SCISEY |
| • Policy & Development in science and Society* | 400 | 4 | 4603SCPDSY |
| • Research in science communication* | 400 | 4 | 4603SCRSCY |
| • Science Journalism (ENG)* | 400 | 4 | 4603SCSJ4Y |
| • Wetenschapsjournalistiek (NL)* | 400 | 4 | 4603SCSWJY |
| • Science Communication product development** | 400 | 4 | 4603SCPRDY |
| • SCS: Scientific Narration and Visualization* | 500 | 3 | 4603SCNV3Y |
| • Internship | | | |
| • SCS Project Proposal | 600 | 3 | 4603SCSPPY |
| • SCS Internship(s) | 600 | 14-34 | 4603SCSS1Y |
| • Additional elective | | | |
| • SCS elective | 400-500 | 1-okt | 4603SCSELY |

Required is a total of at least 120 EC.

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

7. Specialisation Education

7.1 Description (Course and Examination Regulations chapter 2)

The specialisation Mathematics and Education (EDU) prepares students for a career as mathematics (wiskunde) teacher qualified to teach in Dutch secondary education.

Students who complete the specialisation Mathematics and Education are admissible to a PhD programme.

7.2 Programme (Course and Examination Regulations chapter 3)

The Mathematics and Education (EDU) programme consists of:

- a research project in Mathematics of minimally 20 EC (incl. a thesis and an oral presentation) in one of the research groups of the Leiden Mathematical Institute;
- minimally 30 EC of courses to be selected in correspondence with the research topic, summing up to a total of at least 60 EC for these courses and the research project; and
- the Education component as described [here](#).

Required is a total of at least 120 EC. When the student has passed the minor Education (30 EC) during the BSc programme, the compulsory Education component is reduced with 30 EC. The remaining 30 EC can be used for both the Mathematics and the Education component of the MSc programme.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

Students who started the master programme before 2018-2019 have the choice to follow the old programme consisting of a research project in Mathematics of 40 EC, with 20 EC of courses in correspondence with the research topic, or to opt for the new variant, as agreed with the study advisor.

8. Specialisation Statistical Science for the Life and Behavioural Sciences

The programme of the specialisation Statistical Science for the Life and Behavioural Sciences of the MSc programme Mathematics is identical to the MSc programme Statistics and Data Science. For the description and programme of the (former) specialisation within Mathematics, see the MSc Statistics and Data Science.

As of September 1, 2016 no new students are admitted to the specialisation Statistical Science for the Life and Behavioural Sciences of the MSc programme Mathematics.

MSc Media Technology

CROHO-number 60206

1. Description of the programme (Course and Examination Regulations chapter 2)

The Media Technology MSc Programme is part of the Leiden Institute of Advanced Computer Science (LIACS). In addition, it is affiliated with the Academy for Creative and Performing Arts.

Media Technology recognises creativity and playfulness as important factors in scientific innovation. It provides an environment where students and researchers are allowed to formulate their own scientific questions and are encouraged to translate their personal inspirations and curiosities into manageable and compact research projects. The programme encourages unusual questions, unconventional research methods and alternative forms of scientific output besides academic articles. This includes interactive installations, games, robots, books, and more, as results from research.

To achieve this, the curriculum focuses on creative exploration and on the understanding of (the fundamentals of) science and technology. In its elective space the programme encourages its students to draw from the knowledge available throughout Leiden University's various faculties and the ArtScience programme of the Royal Conservatoire and the Royal Academy of Arts in The Hague, or from courses offered at other universities in the Netherlands or abroad.

Besides completing the curricular and elective courses (see "Programme" below), each student must successfully complete an individual Graduation Project guided by two supervisors. It aims to answer a student's personally developed scientific question, possibly by creating a product or experience. A paper is written, presented and publicly defended as part of the Graduation Project. The paper generally takes the form of a scientific article, possibly augmented with alternative output such as a computer programme, installation, public performance, book, etcetera.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The programme's goal is to stimulate innovation and creativity in scientific research by innovative application of technology. Media Technology students are trained as autonomous scientists, preparing students for a future career involving creative and critical thinking, for a future in scientific research.

1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the MSc in Media Technology have attained the following general learning outcomes:

- g. theoretical and practical skills in more than one specialist area (including computer science/artificial intelligence, creative and performative arts, and relevant aspects of philosophy, cognitive science, and linguistics), such that they can carry out research under overall supervision;
- h. the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others;
- i. the ability to interrelate and integrate various areas of computer science, artificial intelligence, creative and performative arts with relevant aspects of philosophy, cognitive science, and linguistics;
- j. the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication;

- k. sufficient understanding of the social and societal role of academia, especially computer science/artificial intelligence and the creative and performative arts, to be able to critically reflect upon it and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties;
- l. have the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous.

In addition to the above general achievements, graduates of the MSc in Media Technology have formed an understanding of the fundamental principles and organisation of academia, and of the importance of creativity and playfulness in academic research. They have knowledge and skills in computer programming and in the use of various media and technologies within virtual and physical environments. They have the ability to communicate with colleagues/peers in science (via e.g. a conference contribution or scientific publication) as well as with a wider public (via e.g. an exhibition, performance, public event, or in popular-scientific writing). They have the ability to act as independent researchers and thinkers with a critical attitude.

1.3 Programme duration and completion Course and Examination Regulations art. 2.5)

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree 'Master of Science in Media Technology'.

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February.

1.5 Language of the programme (Course and Examination Regulations art. 2.8)

The programme is taught entirely in English.

2. Programme (Course and Examination Regulations chapter 3)

The programme comprises 120 EC and consists of the following courses and components:

| Core courses | Level | EC |
|----------------------------------------------------------------------|--------------|-----------|
| Media Technology Field Trip ⁴¹ 4383MTFT4Y | 400 | 1 |
| Creative Programming ⁴² 4383CRPR6Y | 400 | 6 |
| Human Computer Interaction & Information Visualization 4383HCIIVY | 400 | 6 |
| Research Fundamentals 4383RESF3Y | 400 | 3 |
| Playful & Creative Science 4383PLCRSY | 500 | 6 |
| Essentials in Art & Music 4383EAMU3Y | 500 | 3 |
| Hardware & Physical Computing 4383HPC3XY | 400 | 3 |
| Meta Media 4383MEMEXY | 500 | 2 |
| Sciences & Humanities 4383SCHX4Y | 400 | 4 |
| Non-Human Cognition 4383NHCG4Y | 500 | 4 |
| Artificial Creatures 4383ARTCRY | 500 | 4 |
| Sound, Space & Interaction 4383SSPIXY | 500 | 6 |

⁴¹ This course is a renaming of the *Ars Electronica Festival* core course from 2020-2021.

⁴² This course is not available to students who completed *Introduction to Programming* (Level 400, 4 EC) before 1 September 2020.

| | | |
|------------------------------------------------------------|-----|----|
| Exhibition: Science to Experience ⁴³ 4383EXSC1Y | 500 | 12 |
| Portfolio 4383PORTFY | 400 | 1 |
| Graduation Lab 4383GRDLVY | 400 | 1 |
| Graduation Project 4383GRD30Y | 600 | 30 |

Accent courses (choose 2 or 3 out of 5)

| | | |
|------------------------------------------------------|-----|---|
| Computational Creativity 4383COMCRY | 500 | 6 |
| Research Seminar: Artificial Intelligence 4383RSAIXY | 500 | 6 |
| Research Seminar: Social Technologies 4383RSSTXY | 500 | 6 |
| Scientific Narration & Visualization 4603SCNV3Y | 500 | 3 |
| Video Games for Research 4383VGFR6Y | 500 | 6 |

Elective courses 400+ 10-19

Students are expected to take the core courses⁴⁴ with a total of 92 ECTS including the Graduation Project. The remaining 28 ECTS are obtained through a combination of accent courses and elective courses. Student must take minimally 2 and no more than 3 accent courses.

2.1 Substitution for Compulsory Courses

Students can qualify for substitution of certain compulsory courses (especially, but not exclusively, Creative Programming and Research Fundamentals) within their curriculum, when they can prove already having current knowledge of the topics dealt with. Substitution can be granted by the Board of Examiners, who consult the Media Technology Executive Committee and course lecturer. As a guideline, the student must participate in the first lecture and present some form of proof that the knowledge was already obtained elsewhere. The Executive Committee and/or lecturer may advise the Board of Examiners to honour or turn down requests for substitution, based on the material provided by the student and the evaluation of such.

In case the request for substitution is honoured, the student must obtain the required number of ECs through other ways, i.e. for every granted substitution a student must follow another (elective) replacement course with the same number of credits or more. The contents of this replacement course must preferably be a logical extension to the course for which substitution was granted, and must be of at least the same level.

2.2 Acceptance of Elective Courses

Elective courses can be done throughout Leiden University's various faculties, and from any accredited institute of higher education in the Netherlands or abroad. For curricular acceptance of elective courses, permission must be obtained from the LIACS Board of Examiners. The decision to accept an elective course is based on course level, course load, course content and the student's personal statement of motivation. Practical guidelines for students and procedures to apply for curricular acceptance of elective courses are communicated via the programme's website. In addition, an annual "electives kick-off meeting" is organised in which students are timely informed about the possibilities and procedures.

⁴³ This course substitutes *Exhibition: Statement to Experience* (Level 500, 12 EC), and therefore it is not available to students who completed the previous version before 1 September 2020.

⁴⁴ The courses *New Media & New Technologies* (level 500, 5 EC) and *Language Evolution* (level 500, 5 EC) if completed before 1 September 2020 are considered as core courses.

2.3 Option for exchange and studying abroad

Students can apply for permission from the LIACS Board of Examiners to participate in an exchange (typically taking place in the student's 3rd semester). If this permission is granted, the study results obtained within the exchange replace the Accent Courses and elective space. In consultation with the Executive Committee, the Board of Examiners takes the following criteria into consideration:

- the exchange must take place at a qualified institution and programme in The Netherlands or abroad;
- the exchange should consist of a coherent “package” of courses, all taken at one institution, and cover (at least) 28 EC;
- the exchange should take place at MSc level or equivalent;
- the student has a strong and content-driven motivation to participate in the exchange, reflected in the application submitted to the Board of Examiners and Executive Committee, as well as in the will and capacity to pro-actively organise the exchange in all its facets (courses, timeline, costs, housing, etc.).

Independent from this 28 EC exchange option, students can always apply for taking elective courses abroad. For this, the normal procedure for the acceptance of elective courses, as described above, applies.

3. Admission to the programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.⁴⁵

3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in a relevant discipline from a research university in the Netherlands, or from a foreign research university of similar level, such as computer science (informatica), artificial intelligence, communication and/or information science, cognitive science, biology, linguistics, or creative/performing arts; or
- b. holders of a bachelor's degree who have also successfully met the requirements of the imposed bridging programme on the basis of Article 3.4.1

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a

⁴⁵ [Regulations for Admission to Master's Programmes](#)

degree specified 3.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 3.2.4.

Article 3.2.2 may, amongst others, apply to holders of a degree from a University of Applied Sciences (hoger beroepsonderwijs, hbo). As a guideline for applicants with a Dutch hbo diploma, the hbo diploma has to be obtained within a maximum of five years and with an average final grade of at least 7.5. Eventual deficiencies up to 30 EC can be removed upon discussion with the study advisor using a bridging programme (see 3.4).

Admission process

Applicants as referred to in Article 3.2.1.a and Article 3.2.2 are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- Curriculum vitae
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified in 3.2.1.a.
- Two reference letters

The admission process may include an interview with the Board of Admissions, should this be necessary to determine meets the requirements as specified in 3.2.1.a. and 3.2.4.1.

3.2.3 Dutch and English languages⁴⁶

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An [International Baccalaureate](#) diploma (with English A);
- A diploma of secondary or higher education completed in the Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

⁴⁶ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

3.2.4 Qualitative admission requirements

3.2.4.1 Alongside the requirements specified in 3.2.1.a. and 3.2.2, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

- Demonstrable affinity and experience with **fundamental and/or knowledge-driven research** that aims at contributing new insights to academic discourses and is not primarily directed at solving (engineering, societal, commercial etc.) problems;
- Demonstrable affinity and experience with **technology** and its embedding in the human context;
- A **creative** attitude towards science and research in the sense of the programme, i.e. not necessarily demonstrated by artistic creativity, but by the abilities to think and reason beyond disciplinary borders and/or be open to unconventional ways of producing and disseminating academic knowledge.
- Affinity with, and demonstrable (basic) mastering of, imperative programming. Examples of imperative programming languages are Processing, C, C++, Java, Python and assembly languages.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

3.4.1 The department has developed bridging programmes in order to resolve deficiencies. For students with bachelor's degrees in relevant disciplines but lacking a background certain knowledge/skill the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme.

3.4.2 Information on the bridging programmes can be requested from the LIACS Education Office.

MSc Physics

CROHO-number 60202

1. Description of the programme (Course and Examination Regulations chapter 2)

Leiden University offers an MSc programme in Physics. Students who complete the programme receive the degree Master of Science in Physics, with specification of the specialisation. All specialisations have the same Director, the same Board of Examiners, and the same Departmental Teaching Committee. For the specialisation--specific part the specialisations Business Studies (BS), Science Communication & Society (SCS), and Education (EDU), each have their own specialisation coordinator and a Board of Examiners appointed by the Faculty of Science.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The programme offers a solid background and a thorough experience at the forefront of physics research in the respective specialisation, including practical training in communication and computational skills. The programme aims at training students as independent researchers and provides them with the necessary skills to advance their career. Upon completion of the degree, the MSc graduate will be well equipped to start a PhD, work in research and development, or in other branches of the public and private sector that require strong analytical, computational, and problem-solving skills. The 'Casimir pre-PhD' specialisation puts special emphasis on the preparation for PhD research within the Casimir Research School and offers the opportunity to raise one's funding for a PhD.

1.2 Specialisations (Course and Examination Regulations art. 2.2)

The MSc programme in Physics has nine specialisations. Six of the nine specialisations are research specialisations in the Leiden Institute of Physics (LION), including one in collaboration with the Leiden Observatory and one in collaboration with the Delft University of Technology. These are:

- Research in Physics, Theoretical Physics
- Research in Physics, Biological and Soft Matter Physics
- Research in Physics, Quantum Matter and Optics
- Research in Physics, Cosmology
- Research in Physics; pre-PhD ('Casimir')
- Research in Physics, Classical/Quantum Information

The full programme of these specializations is in English. A short description is as follows:

- Theoretical Physics aims to describe and understand a broad range of physical phenomena through a variety of analytical concepts and methods and by encoding them into mathematical language.
- Research within the Physics and Biological and Soft Matter specialisation is mainly experimental and is typically performed at the interface of medical, biological, chemical and physical sciences. Its study focus ranges from the physical processes of biomolecules, the emerging properties that evolve in cells, and the control of cell function by signalling, to the study of the mechanical and geometrical properties of soft media, such as granular matter or foam, and the self-assembly in soft-matter systems.

- Research in the Quantum Matter and Optics specialisation is also mainly experimental. It covers research topics like: the emergence of material properties from a combination of quantum mechanical confinement, electron-electron interaction, and/or electron spin properties, photon-matter interaction, and the quantum properties of light.
- The Cosmology specialisation is offered in collaboration with the Leiden Observatory. Characteristic elements of this specialisation are theory, data handling, and numerical simulations. It covers research subjects like: observations of the universe with state-of-the-art telescopes, supercomputer simulations of the structure of the universe, and theoretical physics studies of the hot big bang, the expanding universe, and inflation.
- The 'Casimir pre-PhD' specialisation is offered under the auspices of the Casimir Research School, a joint effort of the LION and various departments at the Delft University of Technology. It is a selection track that can be followed from any of the aforementioned specialisations. It offers extra challenge in the form of multiple projects in both theoretical and experimental topics and culminates in a PhD proposal that enters a funding competition.
- The specialisation in Classical/Quantum Information sits on the interface of Physics and Data Science. It covers a variety of topics, from the physical principles underlying machine learning and artificial intelligence, to information-science aspects of Quantum Computing. It offers flexible research possibilities for projects on these topics addressing physics challenges with modern data science tools.
-

The remaining three specialisations combine research in physics with Business Studies (BS), with Science Communication & Society (SCS), or with Education (EDU). The research part of these MSc programmes is in English, as is the Business and Communication Studies; the Education component is in Dutch. A more detailed description of these specialisations is given below.

1.3 Learning outcomes (Course and Examination Regulations art. 2.3)

(A) KNOWLEDGE AND UNDERSTANDING

On completion of the programme, the student should:

- A1 have a good understanding of the important physical theories (logical and mathematical structure, experimental support, physical phenomena described).
- A2 be familiar with the most important areas of physics and with the common approaches, which span many areas in physics.
- A3 have a good knowledge of the state of the art in (at least) one of the presently active topics in physics research.

(B) APPLYING KNOWLEDGE AND UNDERSTANDING

On completion of the programme, the student should:

- B1 be able to frame, analyse and break down a problem in phases defining a suitable algorithmic procedure; be able to evaluate clearly the orders of magnitude in situations which are physically different, but show analogies, thus allowing the use of known solutions in new problems.

- B2 be able to identify the essentials of a process/situation and to set up a working model of the same; be able to perform the required approximations; i.e. critically think about how to construct physical models.
- B3 be able to understand and master the use of the most commonly used mathematical and numerical methods.
- B4 have become familiar with most important experimental methods and be able to perform experiments independently, as well as to describe, analyse and critically evaluate experimental data; and to be able to scientifically report the findings. (does not apply to students in the theory specialisation)
- B5 be able to use appropriate software, programming language, computational tools and methods in physical and mathematical investigations.
- B6 acquire an understanding of the nature and ways of physics research and of how physics research is applicable to many fields other than physics, e.g. engineering; be able to design experimental and/or theoretical procedures for: (i) solving current problems in academic or industrial research; (ii) improving the existing results.

(C) JUDGEMENT

On completion of the programme, the student should:

- C1 be able to develop a personal sense of responsibility; be able to gain professional flexibility through the wide spectrum of scientific techniques offered in the curriculum; be able to organize the personal learning process, evaluate personal work, consult experts for information (e.g. about career opportunities) and support when appropriate; have had the opportunity to take courses that prepare for teaching physics at secondary school, as well as the opportunity to gain in-depth interdisciplinary skills.
- C2 have become familiar with highly regarded research in the field, thus developing an awareness of the highest standards.
- C3 be able to understand the socially related problems related to the profession, and to comprehend the ethical characteristics of research and of the professional activity in physics and its responsibility to society; be able to conduct processes of decision making and inspect the consequences of actions taking into account principles, norms, values and standards both from a personal and a professional standpoint.
- C4 be able to work with a high degree of autonomy, even accepting responsibility in (project) planning, and in the managing of structures.

(D) COMMUNICATION

On completion of the programme, the student should:

- D1 be able to listen carefully and to present difficult ideas and complex information in a clear and concise manner to a professional as well as to lay audiences; be able to work in a multidisciplinary or in an interdisciplinary team.
- D2 be able to read, speak, and write in technical English.

(E) LEARNING SKILLS

On completion of the programme, the student should:

- E1 be able to search for and use physical and other technical literature, as well as any other sources of information relevant to research work and technical project development.
- E2 be able to enter new fields through independent study; have developed those learning skills that are necessary for them to continue to undertake further study with a high degree of autonomy (lifelong learning).
- E2 enjoy the facility to remain informed of new developments and methods, and be able to provide professional advice on their possible impact or range of applications.

The aforementioned qualifications, which are derived from the international domain-specific reference framework for Physics, apply to all specialisations of the MSc Physics. For the six research-oriented specialisations they are complete. The three society-oriented specialisations have the following additional qualifications:

| |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Business Studies |
| BS1- Insight in managerial issues related to knowledge-intensive businesses and basic theoretical skills in business disciplines most relevant to working in these businesses; |
| BS2- The ability to make a plan for a new business or an innovation project; |
| BS3- Experience with performing business activities in an existing company or organization or directed towards technology-based business creation. |
| Science Communication and Society |
| SCS1- Knowledge of and skills in science communication theory and methods ; |
| SCS2- Experience in science communication practice; |
| SCS3- Knowledge of ethical, historical and social aspects in the area of the natural sciences. |
| Education |
| EDU1- all qualifications necessary for teaching all years of secondary education and technical and vocational training (students from 12 to 18 years old); |

The general qualifications of Faculty of Science are linked to the final learning outcomes of the programme as depicted below:

| Final qualifications of Faculty of Science | Final learning outcomes MSc Physics |
|------------------------------------------------------------------------------------------------|----------------------------------------|
| A. Knowledge and understanding | |
| A graduate has: * the ability to interrelate and integrate various areas of the discipline; | A1, A2, and A3 |
| B. Applying knowledge and understanding | |

| | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------|
| * theoretical and/or practical skills in more than one specialist area of the discipline such that they can carry out research under overall supervision; * the ability to make an independent analysis of scientific problems, analysis of relevant specialist literature, formulate verifiable hypotheses, and set up and carry out research and critical reflection on one's own research and that of others; | B1, B2, B3, B4, B5, and B6 |
| C. Judgement | |
| * sufficient understanding of the social role of the natural sciences to be able to reflect upon them and in part consequently to come to an ethically sound attitude and corresponding execution of one's professional duties; | C1, C2, C3, and C4 |
| D. Communication | |
| * the ability to present clearly, verbally as well as in writing, one's own research results, and the ability to communicate with colleagues and to present their research results as a contribution to a congress or as (part of) a scientific publication; | D1 and D2 |
| E. Learning (Skills) | |
| * the learning skills to allow them to continue to study in a manner that may be largely self-directed or autonomous. | E1, E2, and E3 |

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

The standard programme starts at the beginning of the academic year in September. Late admission in February is possible for those students who are able to show that they are proficient in the required courses for the relevant specialisation, but it is usually not possible to complete the studies in two years when the programme is started in February. The specialisations 'Cosmology' and 'Casimir pre-PhD' always start in September only.

2. Programme (Course and Examination Regulations chapter 3)

The duration of the programme is two years (120 EC). The nine specialisations are distinguished by a programme and a curriculum that emphasize the intended perspective and goal of the specialisation. Each programme consists of two components: a set of courses and one or more research projects. The selection of courses differs per specialisation and always comprises a mandatory part and an elective part. For the elective part, a minimum number of ECs has to be selected from lists of pre-approved courses. Other electives can be selected from either the pre-approved courses or from other courses offered within all specialisations in our MSc Physics programme. Students can also take certain elective courses from the physics MSc programme at the Technical University of Delft and -if appropriate- from other Dutch Universities, subject to approval from the Study Advisor and the Board of Examiners. Up to one course from a different MSc programme outside Physics can also be selected, subject to approval from the Study Advisor and the Board of Examiners. Details about the programme of each specialisation are given below.

The course programme selected by each individual student is set in a study plan that is discussed and agreed with the Study Advisor at the start of the studies. Approval of the study plan by the Study Advisor expresses the approval by the Board of Examiners. Students are allowed to change their study plan, but should again ask formal approval via the same route.

3. Admission to the programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.⁴⁷

3.2 Admission to the programme

3.2.1 In accordance to Article 7.30b (1) of the Act, the following candidates may be admitted to the programme and one of its specialisations:

- a. holders of a bachelor's degree in Physics (Natuurkunde) from a research university in the Netherlands, or
- b. holders of a bachelor's degree in a Physics-related programme from a research university in the Netherlands or from a foreign research university of similar level, under the provision that the candidate has acquired sufficient in-depth knowledge and skills through undergraduate courses with a theoretical and mathematical emphasis, including courses in
 - quantum physics,
 - electrodynamics,
 - statistical physics, and
 - complex analysis,

equivalent to those of the undergraduate Physics curriculum referred to under a.

or,

- c. holders of a bachelor's degree who have additionally passed the prescribed pre-master's programme pursuant to Article 3.4.1

3.2.2 The Board of Admissions may, upon request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions, without prejudice to the conditions specified in 3.2.4.

Admission process

Applicants as referred to in Article 3.2.1. b and Article 3.2.2 are requested to provide the Board of Admissions with:

⁴⁷[Regulations for Admission to Master's Programmes](#)

- copies of diploma(s) and transcript(s);
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1.a;

The Board of Admissions reserves the option to interview the candidate.

3.2.3 Dutch and English languages⁴⁸

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of these regulations) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An [International Baccalaureate](#) diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of the French-language programmes in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set:

- IELTS: minimum 6.5, with a minimum of 6.0 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 90, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*. The Education specialisation of this master's programme sets the following Dutch language requirements: TUL exam (Toelatingsexamen Universiteit Leiden) - Gevorderd.

3.2.4 Qualitative admission requirements

3.2.5.1 In addition to the requirements specified in 3.2.1 and 3.2.2, the following qualitative admission requirements apply for the programme pursuant to Article 7.30b (2) of the Act:

1. For the specialisation "Research in Physics, Cosmology" knowledge of 'Physics of Elementary Particles' at undergraduate level is required.

⁴⁸ Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

2. The Casimir pre-PhD specialisation is an honour's track that students can enter only after the first semester. For this specialisation the following admission requirements apply:
 - A grade point average of 7.5 in the first semester of the Physics programme is required.
 - Admission to the second year is on the condition that all courses of the first year (60 EC) have been successfully completed.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsections a and b, or an equivalent diploma with x (may vary from 1 to 15) ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

3.4.1 The department offers a bespoke bridging programme (for the following target groups) in order to remove deficiencies:

For students with bachelor's degrees other than Physics or Astronomy the Board of Admissions may impose a Pre-Master's programme, tailored to the individual background of the prospective student, before admission into the MSc programme. This Pre-master's programme consists of maximally 60 EC and is agreed with the Board of Admissions, via the Study Adviser. It will remedy deficiencies in the following list of mandatory 2nd year BSc Leiden Physics courses:

- Linear Algebra 2NA (with prerequisite of Linear Algebra 1NA), 6 EC 4082LA2NAY (4082LIAL2Y)
- Analysis 3NA (with prerequisites of Analysis 1NA + 2NA), 6 EC 4082AN3NAY (4081AN1NAY+ 4081AN2NAY)
- Quantum Mechanics 1 + 2, 11 EC 4062QUM16Y+ 4062QUME2Y
- Statistical Physics 1, 6 EC 4062STAF1Y
- Classical Electrodynamics (with prerequisite of Electromagnetic Fields), 4 EC 4062KLSELY (??)
- Classical Mechanics B (with prerequisite of Classical Mechanics A), 3 EC 4062CLMB3Y (4061KLASAY)
- Introduction to Solid State Physics, 3 EC 4062IVSF3Y
- Physics Experiments 1 + 2 + 3, 10 EC 4062PHEX3Y+ 4062PHEX5Y+ 4062PHEX2Y

and may include a selection of elective courses. Students should be familiar with computer programming, preferably in Python, at the level of the Programming Methods NA. In order to follow such program the student must have sufficient proficiency of the Dutch language, having passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*;

4. Specialisation Research in Physics, Theoretical Physics

4.1 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Effective Field Theory 4403EFTH3Y | 500 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Quantum Theory 4403QUTH6Y | 400 | 6 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Statistical Physics b 4403STPHBY | 400 | 3 |
| Topics in Theoretical Physics 4403TTP21Y | 400 | 6 |
| Elective courses from MSc Physics programme, with ≥ 12 EC from list of preapproved electives presented below, and max. 6 EC from other MSc programmes | 400-600 | 42 |
| Physics research project in Theoretical Physics @ LION (division: research=36 EC, thesis=8 EC, and presentation=4 EC) | 600 | 48 |

Each project must be approved by the study advisor before the start. All research projects are performed under the responsibility of a LION staff member. The project can be either fully theoretical or theoretical/experimental, but if so it must be for the major part (>70%) theoretical. Data analysis may be part of the project, but the essence/main goal must be physics.

| Preapproved electives: Theoretical Physics | Level | EC |
|-------------------------------------------------------|-------|----|
| Advanced Topics in Theoretical Physics I 4403AT121Y | 600 | 6 |
| Advanced Topics in Theoretical Physics II 4403AT221Y | 600 | 6 |
| Applied Quantum Algorithms 4343APQALY | 500 | 6 |
| Black Holes and Gravitational Waves * 4403BHWG3Y | 500 | 3 |
| Complex Networks 4609COMNWX | 400 | 6 |
| Computational Physics 4403CMPH6Y | 400 | 6 |
| Computational Physics 4403CMPH3Y | 400 | 3 |
| Origin and Structure of the Standard Model 4403OSSM3Y | 500 | 3 |
| Particle Physics and the Early Universe 4403PPEU3Y | 500 | 3 |

| | | |
|-----------------------------------------|-----|---|
| Quantum Field Theory 4403QFTH6Y | 500 | 6 |
| Soft and Bio-matter Theory 4403SBMT6Y | 500 | 6 |
| Theoretical Cosmology * 4403THCO3Y | 500 | 3 |
| Theory of Condensed Matter 4403TCM06Y | 500 | 6 |
| Theory of General Relativity 4403TGR64Y | 400 | 6 |

Most courses (including those mandatory) are offered every year. The rest (indicated with *) are offered less frequently, usually in alternate years. The course offering is subject to change.

5. Specialisation Research in Physics, Biological and Soft Matter Physics

5.1 Programme (Course and Examination Regulations chapter 3)

| | | |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Soft and Bio-matter Theory 4403SBMT6Y | 400 | 6 |
| Elective courses from MSc Physics programme, with ≥ 12 EC from list of preapproved courses presented below, and max. 6 EC from other MSc programmes | 400-500 | 42 |
| Research project in Physics 1 (division: research=20 EC, thesis=3 EC, and presentation=1 EC) | 600 | 24 |
| Research project in Physics 2 (division: research=30 EC, thesis=4 EC, and presentation=2 EC) | 600 | 36 |

Each project must be approved by the study advisor beforehand. At least one of the two projects has to be carried out in an experimental group. All research projects are performed under the responsibility of a LION staff member. Up to one project can be carried out outside LION.

| Preapproved Electives: Biological and Soft Matter Physics | Level | EC |
|------------------------------------------------------------------|--------------|-----------|
| Biophysics 4403BIOPHY | 500 | 6 |
| Advanced Optics 4403ADVOPY | 500 | 6 |
| Computational Physics 4403CMPH6Y | 400 | 6 |
| Computational Physics 4403CMPH3Y | 400 | 3 |
| Frontiers of Measurement Techniques 4403FRMT3Y | 400 | 3 |
| Mechanical Metamaterials * 4403MOMM6Y | 400 | 6 |

| | | |
|----------------------------------------------------------------------------|-----|---|
| Molecular Electronics (<i>in collaboration with TU Delft</i>) 4403MOLE6Y | 500 | 6 |
| Single Molecule Optics * 4403SIMOPY | 500 | 6 |
| Technological Biophysics * 4403TBPH3Y | 500 | 3 |
| Statistical Physics b 4403STPHBY | 400 | 3 |
| Topics in Theoretical Physics 4403TTP21Y | 400 | 6 |

| Preapproved BSM courses offered by other departments: | Level | EC |
|--------------------------------------------------------------|--------------|-----------|
| Engineering of Living Systems (TU Delft) | 400 | 3 |
| Advanced Optical Imaging (TU Delft) | 400 | 6 |
| Nanotechnology (TU Delft) | 400 | 6 |
| The Origin and Synthesis of Life (TU Delft) | 400 | 6 |

Most courses are offered every year. The rest (indicated with *) are offered less frequently, usually in alternate years. The course offering is subject to change.

Transitional arrangements: The course 'Biophysics' replaces the old course 'Advanced Biophysics'. Students who started before September 2019 are exempt from the requirement to follow the required courses 'Quantum Information' and 'Soft and Bio-Matter Theory' if they followed the (formerly required) course 'Quantum Theory' instead, unless decided otherwise by the Board of Examiners.

6. Specialisation Research in Physics, Quantum Matter and Optics

6.1 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|----------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Quantum Theory 4403QUTH6Y | 400 | 6 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Elective courses from MSc Physics programme, with ≥ 12 EC from list of preapproved courses presented below, and max. 6 EC from other MSc programmes | 400-500 | 42 |
| Research project in Physics 1 (division: research=20 EC, thesis=3 EC, and presentation=1 EC) | 600 | 24 |
| Research project in Physics 2 (division: research=30 EC, thesis=4 EC, and presentation=2 EC) | 600 | 36 |

Each project must be approved by the study advisor before the start. At least one of the two research projects has to be carried out in an experimental group. All research projects are performed under the responsibility of a LION staff member. Up to one project can be carried out outside LION.

| Preapproved electives: Quantum Matter and Optics | Level | EC |
|--------------------------------------------------------------------------------------------|--------------|-----------|
| Advanced Optics 4403ADVOPY | 500 | 6 |
| Applied Quantum Algorithms (<i>in collaboration with Computer Science</i>) 4343APQALY | 500 | 6 |
| Complex Networks 4609COMNWW | 400 | 6 |
| Computational Physics 4403CMPH6Y | 400 | 6 |
| Computational Physics 4403CMPH3Y | 400 | 3 |
| Condensed Matter Physics 4403COPH6Y | 500 | 6 |
| Effective Field Theory 4403EFTH3Y | 500 | 3 |
| Frontiers of Measurement Techniques 4403FRMT3Y | 400 | 3 |
| Magnetic Resonance Physics * 4403MRPH3Y | 500 | 3 |
| Molecular Electronics (<i>in collaboration with TU Delft</i>) 4403MOLE6Y | 500 | 6 |
| Quantum Optics 4403QOPT6Y | 400 | 6 |
| Physics and Classical/Quantum Information 4403PHCQIY | 400 | 6 |
| Single Molecule Optics * 4403SIMOPY | 500 | 6 |
| Statistical Physics b 4403STPHBY | 400 | 3 |
| Superconductivity * 4403SUPC3Y | 500 | 3 |
| Theory of Condensed Matter 4403TCM06Y | 500 | 6 |
| Topics in Theoretical Physics 4403TTP21Y | 400 | 6 |
| Preapproved QMO courses offered by other departments: | Level | EC |
| Advances in Deep Learning (Computer Science) 4343SADL6Y | 500 | 6 |
| Automated Machine Learning (Computer Science) 4343AUTMXY | 500 | 6 |
| Introduction to Deep Learning (Computer Science) 4343INTDLY | 500 | 6 |
| Introduction to Machine Learning (Computer Science; preferred course) | 500 | 6 |
| Foundations of Statistics and Machine Learning (Mathematics) 4343INTMLY | 500 | 6 |
| Nanotechnology (TU Delft) | 400 | 6 |
| Reinforcement Learning (Computer Science) 4343REINLY | 500 | 6 |
| Surface Science (Chemistry) * 4423SURFSY | 500 | 6 |
| Statistical Learning (Mathematics) 4433STLT6Y | 500 | 6 |

Most courses (including those mandatory) are offered every year. The rest (indicated with *) are offered less frequently, usually in alternate years. The course offering is subject to change.

Transitional arrangements: Students who started before September 2019 are exempt from the requirement to pass the course 'Quantum Information'. The course 'Foundations of Statistics and Machine Learning' replaces the old course 'Information-theoretic Learning'.

7. Specialisation Research in Physics, Cosmology

7.1 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|----|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Large Scale Structure and Galaxy Formation 4303LSSG6Y | 500 | 6 |
| Origin and Evolution of the Universe 4303OEUNIY | 500 | 6 |
| Origin and Structure of the Standard Model 4403OSSM3Y | 400 | 3 |
| Particle Physics and the Early Universe 4403PPEU3Y | 500 | 3 |
| Quantum Theory 4403QUTH6Y | 400 | 6 |
| Theory of General Relativity 4403TGR64Y | 400 | 6 |
| Elective courses from the MSc Physics or MSc Astronomy programme, of which ≥ 12 EC must be Cosmology courses, and max. 6 EC from other MSc programmes | 400-500 | 27 |
| Research project in Cosmology 1 (division: research=26 EC, thesis=3 EC, and presentation=1 EC) | 500 | 30 |
| Research project in Cosmology 2 (Master's project) (division: research=26 EC, thesis=3 EC, and presentation=1 EC) | 600 | 30 |

Both projects must be in Cosmology and must be pre-approved by the Cosmology coordinator and the study advisor. The combination of the two projects must cover three aspects: theory, numerical modelling and data analysis. Typically, the two projects have different supervisors. At least one project must be done at LION.

| Preapproved electives: Cosmology | Level | EC |
|--------------------------------------------------|-------|----|
| Black Holes and Gravitational Waves * 4403BHWG3Y | 500 | 3 |
| Effective Field Theory 4403EFTH3Y | 500 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Theoretical Cosmology * 4403THCO3Y | 500 | 3 |

| Preapproved Cosmology electives offered by Astronomy | Level | EC |
|-------------------------------------------------------------|--------------|-----------|
| Simulation and Modeling in Astrophysics (AMUSE) 4303SIMOAY | 400 | 6 |
| Modern Astrostatistics * 4303MOASSY | 500 | 3 |
| Gravitational Lensing * 4303GRLENY | 500 | 3 |
| Observational Cosmology * 4303OBCOSY | 400 | 3 |

Most courses (including those mandatory) are offered every year. The rest (indicated with *) are offered less frequently, usually in alternate years. The course offering is subject to change.

Transitional arrangements:

- Students who followed the old 6 EC course on 'Particle Physics of the Early Universe' have covered the same study material as currently offered in the combination of the two 3 EC courses 'Origin and Structure of the Standard Model' and 'Particle Physics of the Early Universe'.
- The course 'Modern Astrostatistics' replaces the old course 'Databases and Data Mining'.
- The old Computational Astrophysics (6 EC) course is considered to be equivalent to the course Simulation and Modeling in Astrophysics (AMUSE) (6EC).

8. Specialisation Research in Physics, pre-PhD ('Casimir')

8.1 Description (Course and Examination Regulations chapter 2)

The 'Casimir pre-PhD' specialisation is offered under the auspices of the Casimir Research School, a joint effort of the LION, and various departments at the Delft University of Technology. It is a selection track that can be followed from any of the aforementioned specialisations. This specialisation offers research projects in both Leiden and Delft and requires students to participate in at least one research project at each location.

The programme follows a strict schedule, with the first year devoted to laying the theoretical basis, and the second year to a combination of short intensive research projects and a long MSc thesis project, culminating in the writing of a research proposal for a potential PhD project. The short projects and the proposal writing are special characteristics of the programme, aimed at broadening the research experience of the student.

In the second year of the programme, students will be given the opportunity to attend a Summer School at the start of the academic year. The study projects and MSc research project, scheduled for the second year, are to be carried out in different groups. The PhD research proposal is the last item in the programme. Details can be found on the website of the Casimir Research School.

8.2 Programme (Course and Examination Regulations chapter 3)

The 'Casimir pre-PhD' is a selection track that can be followed from any of the aforementioned specialisations. Its requirements in the first study year copy those of the underlying specialisation. In the second study year, the division over research projects is different though and a research proposal is written (see below).

| | Level | EC |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------|-----------|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Quantum Theory 4403QUTH6Y | 400 | 6 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Elective courses from the MSc Physics programme in Leiden or from the list of Casimir pre-PhD courses in Delft presented below, and max. 6 EC from other MSc programmes | 400-500 | 42 |
| Research project in Physics (division: research=30 EC, thesis=4 EC, and presentation=2 EC) | 600 | 36 |
| Study projects (2x) | 500 | 2 x 8 |
| Research Proposal | 500 | 8 |

All research and study projects must be pre-approved by the Casimir coordinator and the study advisor. One of the 2 study projects must be experimental, the other must be theoretical/mixed theoretical-experimental. The 36 EC research project can be either experimental or theoretical or mixed theoretical-experimental, in line with the student's original specialisation. Occasionally a theoretical research project can be a continuation of the theoretical study project and combined into one 44 EC research project (division: research=34 EC, thesis=6 EC, and presentation=4 EC), with special permission from the Casimir coordinator. Data analysis may be part of the project, but the essence/main goal must be physics.

| Selection of available (Casimir pre-PhD) courses from TU Delft | Level | EC |
|-----------------------------------------------------------------------|--------------|-----------|
| <i>Foundational courses</i> | | |
| Advanced Electrodynamics | 400 | 6 |
| Advanced Solid State Physics | 400 | 6 |
| Continuum Physics | 400 | 6 |
| <i>Topical Courses</i> | | |
| Engineering of living systems | 500 | 3 |
| Fundamentals of Quantum Information | 400 | 6 |
| Mesoscopic Physics | 400 | 6 |
| Molecular Electronics (<i>Leiden/Delft</i>) | 500 | 6 |
| Quantum Communication and Cryptography | 400 | 5 |
| Quantum Hardware 1 – Theoretical Concepts | 400 | 4 |
| Quantum Hardware 2—Experimental State of the Art | 500 | 4 |
| Quantum Optics and Lasers | | |
| The Origin and Synthesis of Life | 500 | 6 |

Methods

| | | |
|----------------------------------------------------------|-----|---|
| Computational Physics 4403CMPH6Y | 400 | 6 |
| Computational Physics 4403CMPH3Y | 400 | 3 |
| Electronics for Quantum Computing | 400 | 5 |
| Molecular Electronics (<i>Leiden/Delft</i>) 4403MOLE6Y | 500 | 6 |
| Nanotechnology | 400 | 6 |

It is unavoidable that the contents of certain courses in Delft and Leiden show significant overlap. To avoid redundancy in the study programme, the combinations of courses given below are mutually exclusive:

- Advanced Solid State Physics (Delft) ⇔ Condensed Matter Physics (Leiden)
- Fundamentals of Quantum Information (Delft) ⇔ Quantum Information (Leiden)}
- Quantum Optics and Lasers (Delft) ⇔ Quantum Optics (Leiden)
- Computational Physics (Delft) ⇔ Computational Physics (Leiden)

Transitional arrangement: Students who started before September 2019 are exempt from the requirement to pass the course 'Quantum Information'.

8.3 Additional qualifications for admission (Course and Examination Regulations chapter 5)

The Casimir pre-PhD specialisation can be followed only after selection. Students admitted to the Physics Programme can apply during the first semester of their studies through the Study Advisor and are selected on the basis of the results in the first semester of the MSc programme. A grade point average of 7.5 in the first semester is required. Formal admission takes place at the start of the second semester. Admission to the second year is on the condition that all courses of the first year (60 EC) have been successfully completed. Students who are not admitted to the second year can continue in one of the other specialisations of the Physics Master. Students who are declined entry either after the first semester or after the first year can continue with the regular programme without incurring delays.

9. Specialisation Research in Physics, Classical/Quantum Information

9.1 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|----------------------------------------------------------------------|-------|----|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Computational Physics 4403CMPH6Y | 400 | 6 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| Introduction to Machine Learning (Computer Science) 4343INTMLY | 500 | 6 |
| Physics and Classical/Quantum Information 4403PHCQIY | 400 | 6 |
| <i>Choice of 2 courses from list of core courses presented below</i> | 400 | 12 |

| | | |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------|-----|
| Elective courses from MSc Physics programme, with ≥ 12 EC from lists of core courses and preapproved courses presented below and max. 6 EC from MSc programmes outside Physics | 400-500 | 18 |
| Research project in Physics with Data Science (division 36 EC: research=30 EC, thesis=4 EC, and presentation=2 EC) | 600 | 36* |
| Second small research project or internship (division 24 EC: research=20 EC, thesis=3 EC, and presentation=1 EC) | 600 | 24* |

* All research projects are performed under responsibility of a LION staff member. The main research project can be extended to 42 EC and combined with a smaller 18 EC project or internship if the project is larger than usual, with the approval of the Study Advisor and the Board of Examiners (division: research=36 EC, thesis=4 EC, and presentation=2 EC).

| Core courses: choose at least 2 from list (rest can serve as elective) | Level | EC |
|-------------------------------------------------------------------------------|--------------|-----------|
| Advances in Deep Learning (Computer Science) 4343ADL6XY | 500 | 6 |
| Applied Quantum Algorithms (Physics, Computer Science) 4343APQALY | 500 | 6 |
| Introduction to Deep Learning (Computer Science) 4343INTDLY | 500 | 6 |
| Foundations of Statistics and Machine Learning (Mathematics) 4373FSML6Y | 500 | 6 |
| Reinforcement Learning (Computer Science) 4343REINLY | 500 | 6 |
| Statistical Learning (Mathematics) 4433STLT6Y | 500 | 6 |
| Preapproved electives: Classical/Quantum Information | Level | EC |
| Automated Machine Learning (Computer Science) 4343AUTMXY | 500 | 6 |
| Complex Networks 4609COMNWX | 400 | 6 |
| Econophysics 4062ECONOY | 400 | 6 |
| Quantum Theory 4403QUTH6Y | 400 | 6 |
| Statistical Physics b 4403STPHBY | 400 | 3 |

Transitional agreement: the course 'Foundations of Statistics and Machine Learning' replaces the old course 'Information-theoretic Learning'. The course 'Econophysics' replaces the (level 300) BSc course of the same name offered in previous years, they are mutually exclusive.

10. Specialisation Business Studies

10.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Business Studies offers students the possibility to combine physics with knowledge, insights, and skills in the area of Management, Business and Entrepreneurship.

Students are encouraged to broaden their horizon, to form opinions, to prepare for a career in industry, and to enhance competences in pursuing entrepreneurial business opportunities stemming from research disciplines.

Students who complete the specialisation Physics and Business Studies are also admissible to a PhD programme.

10.2 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|---------------------------------------------------------------------|---------|-------|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| <i>Elective courses related to the research project</i> | 400-500 | 12 |
| Research project in Physics | 600 | 36 |
| Division: research=30 EC, thesis=4 EC, and presentation=2 EC | | |
| Business Studies component, as described here . | | 40-60 |
| Electives from either the MSc Physics or Business Studies offerings | 400-500 | 20-0 |

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

11. Specialisation Science Communication and Society

11.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Science Communication and Society (SCS) offers students the possibility to combine physics with science communication.

Students are prepared for a career in the popularisation of science or for a career as a scientist with a communication focus.

Students who complete the specialisation Physics and Science Communication and Society are also admissible to a PhD programme in physics or in science communication.

11.2 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|----------------------------------------------------------------------------------|---------|-------|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| <i>Elective courses related to the research project</i> | 400-500 | 12 |
| Research project in Physics | 600 | 36 |
| Division: research=30 EC, thesis=4 EC, and presentation=2 EC | | |
| Science Communication and Society component, as described here . | | 40-60 |
| Electives from either MSc Physics or SCS offerings | 400-500 | 20-0 |

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, exemptions and more information on the complete programme can be found [here](#).

12. Specialisation Education

12.1 Description (Course and Examination Regulations chapter 2)

The specialisation Physics and Education (EDU) prepares students for a career as a physics (Natuurkunde) teacher qualified to teach at the Dutch secondary education as 'eerstegraads docent'.

Students who complete the specialisation Physics and Education are also admissible to a PhD programme.

12.2 Programme (Course and Examination Regulations chapter 3)

| | Level | EC |
|--------------------------------------------------------------|---------|----|
| Academic and Professional Skills 4403ACPRSY | 400 | 3 |
| Quantum Information 4403QINF3Y | 400 | 3 |
| Statistical Physics a 4403STPHAY | 400 | 6 |
| <i>Elective courses related to the research project</i> | 400-500 | 12 |
| Research project in Physics | 600 | 36 |
| Division: research=30 EC, thesis=4 EC, and presentation=2 EC | | |
| Education component, as described here . | | 60 |

The Physics component of the programme is followed during the first year of study, the Education component during the second year.

For students who have completed the minor in Education (30 EC) during the BSc programme, the compulsory Education component is reduced by 30 EC. The freed up 30 EC can be filled by courses from either the Physics or Education offerings.

Transitional arrangements: Students who passed the course 'Quantum Theory' are exempt from the requirement to pass the course 'Quantum Information'. Students who started before 2019 are allowed to have 9 EC in 'Elective courses related to the research project' (old regulation) instead of 12 EC.

A more comprehensive description, qualifications for admission, exemptions and more information on the complete programme can be found [here](#).

MSc Statistics and Data Science

CROHO-number 60957

1. Description of the programme (Course and Examination Regulations chapter 2)

The inter-faculty MSc programme Statistics and Data Science is taught in Leiden by the following institutes:

- Mathematical Institute;
- Department of Biomedical Data Sciences – Leiden University Medical Center;
- Methodology and Statistics – Institute of Psychology – Faculty of Social and Behavioural Sciences;
- Biometris – Wageningen UR;
- Leiden Institute for Advanced Computer Science.

The duration of the programme is two years (120 EC). Students who complete the programme receive the degree Master of Science in Statistics and Data Science.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The goal of the programme is to provide the student with a broad training in applied statistics and data science and their role in science and society. The graduate will be able to apply his/her knowledge and understanding critically, independently, and structurally to model and evaluate complex phenomena arising in a variety of situations. He/she will be well equipped to pursue a career in science, in industry or in the public sector. Qualification to become a PhD candidate is a definite possibility.

Students will gain a thorough knowledge and understanding of statistical models and techniques, which will allow them to develop new statistical and data science methods with application to a broad range of research fields.

Students learn practical skills such as statistical programming, statistical consultation, and written and oral presentation of analysis and research results.

1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

a. Knowledge and understanding

The graduate has a broad knowledge of statistics and its role in science and society. This includes

- a1. a firm grasp of the general concepts of statistical science and data science, with attention for the differences in jargon in different contexts;
- a2. an understanding of statistics and data science as a branch of science and not merely a collection of techniques;
- a3. knowledge of relevant statistical / data science methods, their strengths, assumptions, and limitations;
- a4. deeper knowledge of statistical methods in specific chosen areas of application;
- a5. familiarity with directions of current research in statistical science and data science in specific chosen areas of application;

- a6. knowledge of planning and design of studies;
- a7. knowledge of computing and data management;
- a8. knowledge of mathematical tools that are essential for statistics and data science (including basic calculus, linear algebra).

b. Application of knowledge and understanding

The graduate has the ability to apply his/her knowledge and understanding in a critical, independent, and a systematic approach to model and evaluate complex phenomena arising in a variety of situations. This involves

- b1. the choice of statistical / data science methods for data analysis in concrete applications;
- b2. working with imperfect data;
- b3. the translation between concrete applications and statistical terms;
- b4. the execution of statistical/data analytic tasks with appropriate methods;
- b5. the implementation of methods in computer programs.

c. Judgement and Evaluation

The graduate

- c1. demonstrates the ability for sound statistical judgement both within a scientific and societal context;
- c2. is aware of the ethical implications of the use of statistics;
- c3. has general insight in statistics and data science, its limitations, and its role in society.

d. Communication

The graduate is able

- d1. to explain the role of uncertainty in scientific discourse;
- d2. present and discuss, orally and/or in writing, the results of a statistical or data science analysis, both to statisticians/data scientists and non-statisticians/data scientists;
- d3. engage in a dialogue with an applied researcher in a particular subject area with the purpose to identify and formulate research questions that can be dealt with by statistical analysis;
- d4. explain to substantive researchers the potential and limitations of statistical / data science methods.

e. Learning Skills

The graduate takes responsibility to develop his/her competence, and therefore, will be able to

- e1. recognize gaps in his/her knowledge and to find the resources to fill these gaps;
- e2. find and consult appropriate sources in the international relevant scientific literature;
- e3. recognize a need for novel statistical and data science methods and contribute to their development or implementation;

e4 plan tasks within a given period of time.

1.3 Specialisations (Course and Examination Regulations art. 2.2)

Not applicable

1.4 Start of the programme (Course and Examination Regulations art. 2.6)

Students can start their programme in September or February. However, they are strongly encouraged to start in September when a general introduction to the master programme and most of the compulsory courses are scheduled.

2. Programme (Course and Examination Regulations chapter 3)

2.1 Programma

The curriculum consists of a core programme (56 EC), electives (at most 30 EC), and the thesis project (34 EC):

| Core Programme | EC | Level |
|-----------------------------------------------------------------|-----------|-------|
| Statistics and probability 4433STPRB | 9 | 400 |
| Mathematics for Statisticians 4433MSTT3 | 3 | 300 |
| Statistical Computing with R 4433STCWR | 6 | 400 |
| Statistics and Data Science in Practice ⁴⁹ 4433STDSP | 3 | 400 |
| Linear & Generalized Linear Models and Linear Algebra 4433LAGLM | 9 | 400 |
| Essentials for Data Science ⁵⁰ 4433EDASC | 6 | 400 |
| Statistical Consulting 4433STCON | 5 | 500 |
| Advanced Statistical Computing 4433ADSTC | 3 | 500 |
| Two of the following courses: | | |
| Bayesian Statistics 4433BAYST | 6 | 500 |
| Mixed and Longitudinal Modelling 4433MISLM | 6 | 500 |
| Multivariate and Multidimensional Data Analysis | 6 | 500 |
| | 56 | |
| Preapproved Electives | | |
| Survey Methodology 4433SURMTY | 6 | 500 |
| Survival Analysis 4433SURAN | 6 | 500 |
| Study Designs in the Life and Behavioural Sciences 4433SDLBSY | 6 | 400 |
| Psychometrics and SEM 4433PSYAS | 6 | 500 |
| Statistical Genetics 4433STAGE | 6 | 500 |
| Statistical Learning 4433STLT6 | 6 | 500 |
| High-Dimensional Data Analysis 4433HDDAN | 6 | 500 |
| EMOS Core Module 4433EMOSC | 12 | 500 |

⁴⁹ This course is not available to students who completed Introduction to Life and behavioural Sciences (Level 400, 3 EC) before 1 September 2021.

⁵⁰ This course is not available to students who completed Introduction to Data Science (Level 400, 3 EC) before 1 September 2021.

| | | |
|----------------------------------------------------------------|------------|--------------|
| Introduction to Deep Learning (Computer Science) 4343INTDLY | 6 | 500 |
| Advances in Data Mining (Computer Science) 4343ADVDMY | 6 | 500 |
| | 30 | |
| Thesis project | EC | Level |
| Thesis project 4433THES4Y | 34 | 600 |
| | 34 | |
| Total | 120 | |

2.2 Electives

A maximum component of 12 EC may come from other electives than the listed preapproved electives. For electives other than the preapproved electives, approval has to be obtained from the Board of Examiners before the start of the study components, and it must meet the following criteria:

1. The elective course should be on MSc level;
2. The elective course should not show a (considerable) overlap with or replace compulsory courses or any of the other chosen electives;
3. The elective should have objectives that contribute to the final learning outcomes of the programme (see article 1.2), or provide topical knowledge on the masters' thesis research of the student.

2.3 Transitional arrangements

2.3.1 The thesis project (34 EC) replaces the former separate internship (10 EC) and thesis (24 EC). Students who started before September 2021 are still allowed to plan their thesis and internship as separate projects, provided they did not interrupt their registration.

2.3.2 The course Statistics and Data Science in Practice (3 EC) can be used to replace the course Introduction to the Life and Behavioral Sciences (3 EC) for students who started before September 2021.

2.3.3 The course Essentials for Data Science (6 EC) can be used to replace the course Introduction to Data Science for students (3 EC) who started before September 2021.

2.3.4 After cancellation of a component or major changes to a component, the student is provided with one more option to finish the component in the following academic year, where applicable via partial exams and/or compensatory assignments.

2.4 Examinations, Final Examination (Course and Examination Regulations chapter 4)

2.4.1 Obligatory sequence (Course and Examination Regulations art. 4.2). Students may only take the following courses and sit their attendant examinations once they have passed the examinations for one or more other components:

| | |
|-----------------------------|-----------------------------------------------------------------------------|
| <i>Programme component:</i> | <i>Follow course and sit its attendant examination after having passed:</i> |
| EMOS Core Module | Survey Methodology |

| | |
|-----------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <i>Programme component:</i> | <i>Follow course and sit its attendant examination after having obtained:</i> |
| Statistical Consulting | 45 EC from the programme |
| EMOS Core Module | 42 EC from the programme |
| Thesis project | 42 EC to start the writing of the thesis proposal, 60 EC from the programme to start the Thesis project, and 96 EC from the programme to sit its attendant final examination. |

2.4.2 For the components and their attendant examinations, which must be completed in a given sequence, the Board of Examiners may in special cases, and following a substantiated written request by the student, agree to an alternative sequence.

3. Admission to the programme (Course and Examination Regulations chapter 5)

3.1 Confirmation of admission

3.1.1 The Faculty Board provides confirmation of admission if the student meets the entry requirements specified in Articles 3.2 and 3.3, as long as the maximum number of students that the Executive Board has determined may be enrolled in the programme has not been exceeded. If admission is on the basis of Article 3.2.1, the proof of registration is also confirmation of admission.

3.1.2 Confirmation of admission must be applied for according to the rules set out in the Regulations for Admission to Master's Programmes.⁵¹

3.2 Admission to the programme

3.2.1 Pursuant to Article 7.30b (1) of the Act the following candidates may be admitted to the programme and one of its specialisations:

- a) holders of a bachelor's degree from a research university in the Netherlands or from a foreign research university of similar level, provided that the candidate has:
 - basic knowledge of calculus (equivalent to the Dutch: vwo Wiskunde B), and
 - accumulated at least 20 EC (or the equivalence thereof) in courses/projects in statistics/ methodology and/or mathematics,
- b) the courses/projects referred to in 3.2.1 sub-section a, must have been concluded with an average mark of at least 7.5/10 (or GPA \geq 3.4).

⁵¹[Regulations for Admission to Master's Programmes](#)

3.2.2 The Board of Admissions may, on request, admit persons to the programmes who do not meet the requirements specified in 3.2.1, but who can demonstrate to the satisfaction of the Board of Admissions that they possess the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, sub-sections a and b, possibly under further conditions.

Admission process

Applicants as referred to in Article 3.2.1., subsections a and b, and Article 3.2.2 are requested to provide the Board of Admissions with:

- copies of diploma(s) and transcript(s)
- a letter in which the applicant explains that he/she possesses the same level of knowledge, understanding and skills as holders of a degree specified 3.2.1, subsections a and b.

The admission process may include an interview with the Board of Admissions, should this be necessary to clarify whether the applicant has the same level of knowledge, understanding and skills as holders of a degree specified in 3.2.1, subsections a and b.

3.2.3 Dutch and English languages⁵²

3.2.3.1 As further clarification of Article 2.8 (see Faculty part of this OER) concerning command of the language of instruction, a student who wishes to be admitted to an English-taught master's programme must have one of the following diplomas or must meet the criteria of:

- An [International Baccalaureate](#) diploma (with English A);
- A diploma of secondary or higher education completed in Australia, Canada (with the exception of French taught education in Canada), Ireland, Malta, New Zealand, Singapore, the United Kingdom, the United States or South Africa;
- A diploma of an English-taught university degree programme completed at a Dutch research university;
- A Dutch pre-university education (vwo) diploma.

3.2.3.2 If a student who wishes to be admitted does not meet the requirements in 3.2.3.1, at least one of the following language requirements can be set: *consent FR*, *consultation OC*

- IELTS: minimum 7.0, with a minimum of 6.5 for each of the components Listening, Reading, Writing and Speaking
- TOEFL: internet based 100, with a minimum of 20 for each of the components Listening, Reading, Writing and Speaking
- Cambridge Certificate of Advanced English (CAE), minimum 180, with a minimum component score of 169

3.2.3.3 As further clarification of Article 2.8 concerning command of the language of instruction, a student who is not a native Dutch speaker and who wishes to be admitted to a Dutch-taught master's programme must have passed *TUL-halfgevorderd* (equivalent to state examination NT2-II) or *TUL-gevorderd*.

⁵² Letter of the Minister of Education, Culture and Science of 11 July 2018, decision on costs of standardised tests (costs of standardised tests, including language tests, are to be paid by the study programme from the academic year 2019-2020). This applies for all students. If possible, the Minister will make a decision on a different procedure for students with a diploma from outside the Netherlands.

3.2.4 Qualitative admission requirements

Not applicable.

3.3 Deficiencies

3.3.1 Holders of a bachelor's degree from a research university, referred to in 3.2.1, subsection a, or an equivalent diploma with a maximum of 15 ECTS of deficiencies, may be admitted to the programme, as long as it may reasonably be expected that they will meet the entry requirements within a reasonable period of time.

3.3.2 Students who still have the deficiencies referred to in 3.3.1 when admitted to the programme may participate in the programme but may not sit any final examinations or examinations that the Faculty Board has specified in its decision to grant admission.

3.3.3 For the admission referred to in 3.3.1 the Board of Admissions assembles a catch-up programme with examination opportunities.

3.3.4 If a student is admitted to the programme on the basis of 3.3.1 and must sit examinations to meet the entry requirements, these are not considered part of the curriculum of the Master's programme.

3.4 Bridging programmes (Pre-master's)

Not applicable.

Specialisation Business Studies

1. Description of the programme (Course and Examination Regulations art. 2)

The specialisation Business Studies is for MSc students in the sciences and biomedicine who are interested in management or a career in industry. The objective of the specialisation is to teach students basic analytical frameworks and skills to analyse business-related problems and to contribute to managerial decision making within the context of established knowledge-intensive organisations or new technology ventures.

1.1 Objectives of the programme (Course and Examination Regulations art. 2.1)

The specialisation *Business Studies* aims to provide an introduction to general management theory and practice. In addition, students will gain practical experience in applying their business knowledge and skills through working as an intern in a knowledge-intensive organisation.

The specialisation emphasises interactive teaching that connects with management practice. This means opportunities for students to learn through real-life business case discussions, guest speakers and hands-on business experience in internships.

1.2 Learning outcomes (Course and Examination Regulations art. 2.3)

Graduates of the master programme with specialisation *Business Studies* have become proficient in the use of fundamental conceptual frameworks in business studies

After completion of this specialisation students will have developed

- Familiarity with the 'managerial toolbox' – a basic understanding of foundational concepts and frameworks from different business disciplines.
- Practical skills and experience in applying the 'managerial toolbox' in the context of knowledge-intensive organisations.
- Basic skills in conducting business research.

1.3 Qualifications for Admission (Course and Examination Regulations art. 5)

Admissible to the specialisation Business Studies are all students that are admitted to a Master Programme of the Faculty of Science or the Master Programme in Biomedical Sciences of the Faculty of Medicine (LUMC) provided that the rules and regulations of the subject Master Programme do allow so.

1.4 Programme (Course and Examination Regulations art. 3)

The MSc programme in combination with the Business Studies specialisation consists of two components:

- a component within the chosen MSc programme:
 - [Astronomy](#);
 - [Bio-Pharmaceutical Sciences](#);
 - [Biology](#);
 - [Chemistry](#);
 - [Life Science and Technology](#);
 - [Mathematics](#);
 - [Physics](#); or
 - [Biomedical Sciences \(LUMC\)](#).
- a *Business Studies* component.

The *Business Studies* component comprises at least 40 EC, of which 20 EC should consist of master courses from the Business Studies programme (as listed in the overview below) and minimally 20 EC

of the business internship. An additional maximum of 20 EC of electives can be chosen from the listed courses and electives, or from the MSc programme of choice. The choice of courses and electives should be made in consultation with a study adviser, mentor, or specialisation coordinator.

The specialisation encompasses minimally the following modules:

| | Level | EC |
|-------------------------------------------|--------------|------------------------|
| Strategy and Technology 4603BSSATY | 500 | 5 |
| Marketing Science 4603BSMK3Y | 500 | 3 |
| Strategic Financial Management 4603BSSF3Y | 500 | 3 |
| Operations Management 4603BSOM4Y | 500 | 4 |
| Research Methods 4603BSRM5Y | 500 | 5 |
| Business Internship | 600 | 20/30/40 ⁵³ |

In addition, the following course modules can be included in the Business Studies tracks:

| | Level | EC |
|--------------------------------------|------------------------|-----------|
| Accounting 4603BSAC3Y | 500 | 3 |
| Business Intelligence 4353BUSI3Y | 500 | 3 |
| Digital Transformations 4603BSDT5Y | 500 | 5 |
| Entrepreneurship 4603BSEN3Y | 500 | 3 |
| Leading & Managing People 4603BSLM5Y | 500 | 5 |
| Lean Six Sigma 4603BSLS3Y | 500 | 3 |
| Entrepreneurial Finance 4603BSEF3Y | 500 | 3 |
| AI for Strategy 4603BSAS3Y | 500 | 3 |
| Marketing Analytics 4603BS1MAY | 500 | 3 |
| Management Science 4603BSMS3Y | 500 | 3 |
| Systems Optimisation 4603BSSO3Y | 500 | 3 |
| Electives ⁵⁴ | variable ⁵⁵ | variable |

1.5 Course renaming

As of September 1st, 2021, the following courses have been renamed: *Strategy and Technology* (was *Strategy*), *Marketing Science* (was *Marketing*), *Strategic Financial Management* (was *Financial Management*), and *Operations Management* (was *Technology Operations Management*). Previously completed courses are considered equivalent to those renamed in September 2021.

1.6 Exemptions

Students with prior education in management, business and entrepreneurship may – depending on the contents and extent of said education – be exempted from following (parts of) one or more of the courses. These courses need to be substituted such that their master programme contains at least 20 EC of business courses as mentioned in the overview above and an internship of at least 20 EC. Decisions on exemptions and substitutions are taken by the Board of Examiners.

⁵³ The *Business Internship* is worth 20, 30 or 40 EC, depending on the type and duration of the internship. This is further specified in the Prospectus.

⁵⁴ Electives can be either courses from the Science Based Business (SBB) Business Studies portfolio or courses that are offered as electives elsewhere. They have to be approved by the Board of Examiners after the advice from the SBB Business Studies staff.

⁵⁵ For courses with a level less than 400 or unspecified levels the approval of the Board of Examiners is required next to the approval of SBB Business Studies staff. Students are allowed to include a maximum of 12 EC in courses with a level less than 400 in their total MSc programme.

Specialisation Science Communication and Society

1.1 Description (Course and Examination Regulations chapter 2)

The specialisation Science Communication and Society concerns science communication in a broad sense. The programme prepares students for a career in popularisation of science, for example, as a science communicator, a science policymaker or a public relations or health communication officer, or for a career as a scientist with a communicating mind-set.

Students with an MSc specialisation Science Communication and Society are admissible to a PhD programme in their MSc research field or in Science Communication.

1.2 Qualifications for admission (Course and Examination Regulations chapter 5)

Admissible to the specialisation SCS are all students that are admitted to a Master Programme of the Faculty of Science or the Master Programme in Biomedical Sciences of the Faculty of Medicine (LUMC) provided that the rules and regulations of the subject Master Programme do allow so. Preferably, the BSc programme has included some coursework in (science) communication.

In addition, international applicants must provide proof of proficiency in English with an IELTS ≥ 6.5 .

1.3 Programme (Course and Examination Regulations chapter 3)

The MSc programme in combination with the Science Communication and Society (SCS) specialisation consists of two components:

- a component within the chosen MSc programme:
 - [Astronomy](#);
 - [Bio-Pharmaceutical Sciences](#);
 - [Biology](#);
 - [Chemistry](#);
 - [Computer Science](#);
 - [Life Science and Technology](#);
 - [Mathematics](#);
 - [Physics](#); or
 - *Biomedical Sciences (LUMC)*.
- a Science Communication and Society component⁵⁶.

Preferably, the component within the chosen MSc programme should be followed during the first year of study, the Science Communication and Society component should be followed during the second year.

The SCS specialisation programme comprises at least 40 EC. A maximum of 20 EC of electives can be filled in with either SCS courses, or with components within the MSc programme of choice. The choice of electives should be made in consultation with a study adviser, mentor, or specialisation coordinator.

⁵⁶ Completion of the specialisation Science Communication and Society requires a minimum of 40 EC and a maximum of 60 EC within the SCS component.

The Science Communication and Society component consists of the following:

| SCS courses | Level | EC | Catalog nr |
|----------------------------------------------|--------------|-----------|--------------------------|
| Informal Science Education* | 400 | 4 | 4603SCISEY |
| Policy & Development in science and Society* | 400 | 4 | 4603SCPDSY |
| Research in science communication* | 400 | 4 | 4603SCRSCY |
| Science Journalism (ENG)* | 400 | 4 | 4603SCSJ4Y |
| Wetenschapsjournalistiek (NL)* | 400 | 4 | 4603SCSWJY |
| Science Communication product development** | 400 | 4 | 4603SCPRDY |
| SCS: Scientific Narration and Visualization* | 500 | 3 | 4603SCNV3Y |
| Internship | | | |
| SCS Project Proposal | 600 | 3 | 4603SCSPPY |
| SCS Internship(s) | 600 | 14-34 | 4603SCSS1Y 4603SCSS2Y |
| Additional elective | | | |
| SCS elective | 400-500 | 1-10 | 4603SCSELY |

* **SCS courses** are available as elective course for students who don't follow the SCS specialisation.

** the course **Science Communication product development** is only admissible for students who have completed all other SCS courses.

Internship

The internship will be in the field of science communication (e.g. science journalism, museology, new media, health communication). The total internship period may consist of one internship, or can be divided into 2 smaller internships. Each internship is assessed by an evaluation of 1. the internship performance, 2. a written report and 3. an oral presentation. The entire internship period consists of 14-34 EC depending on the amount of credit needed in the specialisation (40-60EC). The total internship period includes a minimum of 10 EC of research in science communication. The Project proposal is the research proposal that needs to be written during the start of the internship period and provides for an additional 3 EC.

The choice of internships should be approved beforehand by the coordinator of the specialisation and if applicable by the MSc programme coordinator.

Additional elective

The SCS elective is an elective course in which students can perform e.g. a book exam, a literature review, or an independent project related to science communication. Students need to write a project proposal before starting the SCS elective including description of the project, significance and planning. The SCS supervisor needs to approve the proposal before the start of the project. Students outside of the Science Communication and Society specialisation need permission from their exam board and the specialisation coordinator.

Specialisation Education

The specialisation Education is taught in Leiden by the Leiden University Graduate School of Teaching (ICLON).

1.1 Description (Course and Examination Regulations chapter 2)

The MSc specialisation Education prepares students for a career in teaching in their subject matter specialisation. This programme leads up to the so-called “eerstegraads-lesbevoegdheid”, qualifying the student to teach in Dutch upper secondary education in the school subject associated with the MSc programme as indicated in the table below.

| Master programme | Qualifies for school subject |
|-----------------------------|--------------------------------------------------------------------------|
| Mathematics | Wiskunde (Mathematics) |
| Physics | Natuurkunde (Physics) |
| Astronomy | Natuurkunde (Physics) |
| Chemistry | Scheikunde (Chemistry) |
| Bio-Pharmaceutical Sciences | Scheikunde (Chemistry) ⁵⁷ or Biologie ⁵⁸ (Biology) |
| Life Science and Technology | Scheikunde (Chemistry) or Biologie ⁵⁸ (Biology) |
| Biology | Biologie (Biology) |
| Computer Science | Informatica (Computer Science) |

Students with an MSc specialisation in Education are also admissible to a PhD programme in their MSc programme.

1.2 Qualifications for admission (Course and Examination Regulations chapter 5)

Students should be admitted to an MSc programme within the Faculty of Science. The teacher educator of the subject matter will assess if there are deficiencies in the prior education of the student. When deficiencies are identified, the teacher educator will propose how these can be solved.

For all other (international) candidates, the Board of Admissions will judge the equivalence to this BSc degree of their previous training.

Applicants must provide proof of proficiency in Dutch TUL exam (Toelatingsexamen Universiteit Leiden) - Advanced.

1.3 Programme (Course and Examination Regulations chapter 3)

The MSc programme in combination with the Education (EDU) specialisation consists of two components:

- a component within the chosen MSc programme (60 EC):
 - [Mathematics](#),
 - [Astronomy](#),
 - [Physics](#),
 - [Chemistry](#),
 - [Bio-Pharmaceutical Sciences](#),

⁵⁷ Students Bio-Pharmaceutical Sciences wishing to qualify for the school subject “Chemistry”, need to solve their deficiencies in concert with the *teacher educator Chemistry* of the ICLON.

⁵⁸ Students Bio-Pharmaceutical Sciences and Life Science and Technology wishing to qualify for the school subject “Biology”, need to solve their deficiencies in concert with the *teacher educator Biology* of the ICLON.

- [Biology](#),
- [Life Science and Technology](#),
- [Computer Science](#)
- An Education component (60 EC).

The component within the chosen MSc programme should be followed during the first year of study, the Education component should be followed during the second year.

The Education specialisation is offered as a joint programme of the faculty and the Leiden University Graduate School of Teaching (ICLON) and consists of the following components:

| | Level | EC |
|----------------------------------------------|--------------|-----------|
| Educational Theory 4603EETHY | 400 | 5 |
| Learning and Instruction 1 4603EDLINY | 300 | 3 |
| Innovations in Education 4603EDINOY | 400 | 3 |
| Teaching Methodology 1 4603EDVD1Y | 400 | 5 |
| Teaching Methodology 2 4603EDTM2Y | 500 | 5 |
| Subject-specific research project 4603EDVDOY | 600 | 7 |
| Teaching Practice 1 4603EDP17Y | | 17 |
| Teaching Practice 2 4603EDTP2Y | | 15 |

For students who passed the minor Education (30 EC) during the BSc programme, the programme consists of the following:

| | Level | EC |
|---------------------------------------|--------------|-----------|
| Learning and Instruction 2 4603EDLI3Y | 400 | 3 |
| Teaching Methodology 2 4603EDTM2Y | 500 | 5 |
| Design Research 4603EDVDOY | 600 | 7 |
| Teaching Practice 2 4603EDTP2Y | | 15 |

The remaining 30 EC can be used for both the education specialisation and the research component of the MSc programme. For LST and Chemistry the remaining 30 EC are restricted to the MSc programme.