

Master Programme in Mathematics

This guide contains information about the master programme in mathematics offered by Leiden University. There are various master specialisations. Each specialisation may consist of master courses offered by Leiden University, courses offered by the Dutch master programme in mathematics ("Mastermath"), and courses offered by other institutions, in particular the Technical University of Delft.

In case the specific information needed for your individual programme is not given in full detail, do not hesitate to contact one or more of the faculty members listed on the next pages for help.

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**Universiteit Leiden
Faculteit der Wiskunde
en Natuurwetenschappen**

Practical information

Important websites

For more extensive information such as the courses offered in the present academic year, course descriptions, course schedules, uSis, etc. consult the following webpages:

<https://studiegids.leidenuniv.nl/studies/show/mathematics>

(e-prospectus mathematics Leiden University)

<http://pub.math.leidenuniv.nl/~evertsejh/roosters.html>

(class schedules mathematics Leiden University)

<http://studiegids.tudelft.nl> (e-studyguide TU Delft)

<http://huidigeroosters.tudelft.nl> (class schedules TU Delft)

<https://usis.leidenuniv.nl> (uSis)

The people of the programme

The Mathematical Institute is located in the

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Front Office/Student Information Centre Plexus

(enrolment and de-registration, tuition fees, student grants, special enrolment conditions, brochures)

Kaiserstraat 25 (ground floor) 2311 GN Leiden

phone: (071) 527 8011

Opening hours: Monday, Wednesday, Friday 9.00– 17.00, Tuesday, Thursday 9.00 – 21.00

URL: <http://students.leiden.edu/organisation/student-information-desk.html>

Dutch Master programme in Mathematics (“Mastermath”)

The Dutch Master programme in Mathematics (called Mastermath) offers master courses in mathematics which are open to all students following a master programme in mathematics at any of the Dutch universities. These courses are usually given at central places in the Netherlands (mostly Amsterdam or Utrecht). Both the master specialisation Applied Mathematics and the master specialisation Algebra, Geometry and Number Theory (see below) require that at least 30 EC be taken from Mastermath courses.

In general, the Mastermath courses given on Mondays, Tuesdays and Wednesdays are suitable for beginning master students in mathematics. Courses given on Thursdays maybe either basic courses or more advanced courses requiring more pre-knowledge.

Some of the mastermath courses are primarily meant for students who want to follow the master specialisation Mathematics and Education (see below); they are not eligible for any of the other master specialisations.

For a description of the Mastermath courses offered during this academic year as well a schedule see <https://elo.mastermath.nl> . You may also ask the study advisor or a faculty member for further information.

Please notice: for mastermath courses you must ask for an account on the mastermath learning environment <https://elo.mastermath.nl> and register for the courses you take.

Travelling expenses for participation in the Dutch Master Programme in Mathematics are reimbursed by Mastermath. See <https://elo.mastermath.nl> under Travel reimbursement.

Registration for courses, examinations, tutorials, practicals

To be able to participate in educational programmes of the Faculty of Science students have to register via uSis. Without timely registration, participation may become impossible and potentially a grade cannot be registered.

Registration for courses opens six weeks before the start of the semester and closes one week before the activity commences. Registration for a course includes the examination.

Registration for (a re-sit of) an examination is possible up to one week before the day of (the re-sit of) the examination. An oral examination does not require registration in uSis.

The Master Exam

At least 5 weeks before the intended date of the exam, the candidate informs the study advisor for master students about the planned exam, and registers for it at the Graduate School Office („Educatief Centrum) by means of uSis. All grades of the courses and projects completed in the MSc degree programme, as well as the bachelor diploma or any other proof of admission to the master programme, must have been registered at that time.

At the time of registration for the exam, the thesis advisor must have certified that the master thesis meets the requirements for the exam, in particular that it is worth 40 EC. The thesis advisor declares the thesis ready for examination only if

the thesis is completed,

a public talk by the student about the thesis has been scheduled before the exam.

If the thesis is to be prepared within the framework of an internship, at the beginning of the project the thesis advisor must make an arrangement with the enterprise or organisation in case the project will hit at confidential information. In particular, it must be guaranteed that the talk, thesis and presentation resulting from the project are suitable for public presentation and demonstrate the mathematical quality of the work.

The thesis advisor asks at least two other faculty members to read the thesis and to become members of the committee for this exam. In any case, a member of the Board of Examiners, preferably the Director of Education, will act as chairperson of the committee. If the thesis has

been written within the framework of an internship, the external advisor as well is asked to become a member of the committee.

The study advisor checks, in consultation with the Graduate School Office, if all requirements (sufficient credits for the right courses, including the thesis, etc.) are met and discusses the results with the Board of Examiners. If this Board approves the exam, the student agrees with the thesis advisor and the other members of the committee on a date and time and reports this to the student advisor.

The exam takes place in the classroom reserved for it, and is publicly accessible, in particular for friends and relatives of the candidate.

Before the exam takes place, the candidate delivers two hard copies of the thesis to the student advisor and an electronic version (preferably in PDF-format) for publication in the online archive of the MI.

The thesis has to be written in English unless the Board of Examiners allows another language.

On the title page are mentioned:

name of author, title of thesis, name of thesis advisor(s) and date of exam;

Master thesis, Mathematisch Instituut, Universiteit Leiden.

PROTOCOL OF EXAM

The chairperson asks the candidate to explain the contents of the thesis in approximately 15 minutes.

The members of the committee for this exam ask the candidate some questions about the thesis.

The committee adjourns for deliberation. The thesis advisor proposes a grade for thesis and presentation. The board decides on the definite grade.

In the classroom, the chairperson announces the overall grade with which the exam has been passed.

The thesis advisor gives a short personal speech.

A couple of weeks after the ceremony the candidate will receive the diploma.

The Master Programme in Mathematics

Introduction

Leiden University offers six specialisations of an MSc programme in mathematics. Three of these correspond to research specialisations in the Leiden Mathematical Institute. The remaining three are the mathematics specialisation of the research MSc with Science Based Business (SBB), Science Communication & Society (SCS) and Education (EDU) specialisations. 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. Candidates with a BSc degree or equivalent can apply for admission. The admission guidelines are given below for each specialisation. Individual combinations of the research programmes, with research projects from different groups, are possible in principle, depending on the decision by the Board of Examiners. The admission process may include an interview with the Board of Admissions. Foreign applicants must provide proof of proficiency in English (IELTS level 6.0). Admission is possible throughout the year, but we advise foreign students to start in September or February. Further information is available on the website <http://www.math.leidenuniv.nl/en/master>

The goal of each programme is to train the student as an independent researcher, and to develop the necessary skills and proficiency to advance her/his career.

The mathematics courses in a master programme can be taken from

- 1) master courses offered in Leiden;
- 2) courses of the Dutch Master Programme in Mathematics (mastermath);
- 3) master courses in mathematics offered by another institution.

For courses in the 3rd category, the student has to ask the study advisor for permission in advance.

The e-study guide <https://studiegids.leidenuniv.nl/studies/show/mathematics> contains a list of the master courses in mathematics offered by Leiden University during the present academic year. In general, this list of courses may change from year to year, but the courses Complex networks, Ergodic theory and fractals, Differentiable Manifolds 2, Introduction to Dynamical Systems, Linear Analysis, Mathematical statistics, Measure Theory and Multiscale mathematical biology are offered every year.

In addition to this, there are courses which are given on a regular basis but not annually, such as Algebraic number theory, Analytic number theory, Bifurcations and chaos, Diophantine

approximation, Elliptic curves, Introduction to perturbation methods. Further, each year there are courses and seminars on varying topics from algebra, algebraic geometry, dynamical systems, functional analysis, mathematical biology, probability and statistics.

Master specialisation Applied Mathematics

This is a research specialisation aimed at students who wish to become thoroughly acquainted with mathematics as it is applied in various aspects of life. There is a strong theme dealing with Bioscience (see the Leiden Bio Science Initiative), as well as a strong theme dealing with industry and operations research. Leiden offers courses at an advanced level ranging over topics such as dynamical systems, industrial statistics and probability theory. Some of the courses are compulsory, but there is a lot of freedom in choosing one's own topic. Some of the courses are given at the national level.

The programme ends with the preparation of a Master Thesis and an oral presentation of it. 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.

QUALIFICATIONS FOR ADMISSION

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the actual knowledge of the candidate.

PROGRAMME

For each student, a programme will be tailored individually. It consists of a choice of advanced courses (at least 60 EC) on differential equations, dynamical systems, analysis of industrial problems, measure and integration theory, probability theory, statistics, functional analysis, numerical analysis, operations research; a research project in mathematics (at least 40 EC, including 7 EC for the thesis and an oral presentation) and a free choice of courses from any field (maximum 20EC); required is a total of at least 120 EC.

Some courses given in the frame of the master specialisation Statistical Sciences (see <http://www.math.leidenuniv.nl/statscience/>), in particular Statistical learning, may be suited for a programme oriented towards statistics; if you consider taking one or more of these courses, discuss this with the study advisor.

It is compulsory that at least 30 EC be obtained from courses from the national Master programme in mathematics (Mastermath).

Master specialisation Algebra, Geometry and Number theory

This is a research specialisation aimed at students who wish to acquire a profound knowledge of one of the areas within pure mathematics. There is a strong theme dealing with algebra and number theory (see the international ALGANT study programme) as well as a strong theme dealing with topology and geometry. Leiden offers courses at an advanced level ranging over topics such as algebraic number theory, algebraic geometry and cryptology. Some of the courses are compulsory, but there is a lot of freedom in choosing one's own topic. Some of the courses are given at the national level. The programme ends with the preparation of a Master Thesis and an oral presentation of it. 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.

QUALIFICATIONS FOR ADMISSION

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the actual knowledge of the candidate.

PROGRAMME

For each student, a programme will be tailored individually. It consists of a choice of advanced courses (at least 60 EC) from algebra, algebraic and analytic number theory, cryptology, and algebraic and differential geometry; a research project (at least 40 EC) and a free choice of courses from any field (maximum 20 EC); required is a total of at least 120 EC.

It is compulsory that at least 30 EC be obtained from courses from the national Master programme in mathematics (Mastermath).

ALGANT

The Erasmus Mundus study programme ALGANT is a EU funded international master programme in algebra, geometry and number theory, jointly offered by the universities of Bordeaux, Duisburg-Essen, Leiden, Milano, Orsay, Padova and Regensburg. This programme is open to non-Dutch master students. Students following this programme are obliged to take courses from two of the participating universities.

More information about the ALGANT programme can be found on the webpage <http://algant.eu>

Master specialisation Statistical Science for the Life- and Behavioural sciences

The MSc programme Statistical Science provides students with a thorough introduction to the general philosophy and methodology of statistical modelling and data analysis. Students gain knowledge of statistical methods and research designs as used in a broad range of empirical research, and practical skills such as statistical programming, statistical consultation, and written and oral presentation of research results. Students can specialise in applications pertaining to the life sciences or the behavioural sciences.

QUALIFICATIONS FOR ADMISSION

Students with a wide range of bachelor degrees may apply for admission, but the bachelor's degree must include at least one introductory course and a more advanced course in statistics or probability. The candidate student should submit a letter (1 page) stating the student's motivation to apply to the programme, and a Curriculum Vitae, including the courses and credits in the Bachelor programme.

The courses will be taught in English, so proven proficiency in English is required for non-native English speakers (IELTS level 6.0). For information: <http://www.math.leidenuniv.nl/statscience/>.

PROGRAMME

The nominal duration of the programme will be two years (120 ECTS). The study time may be substantially reduced for students with particular prior knowledge. The programme consists of courses and colloquia (84 EC), and an internship and writing of a Master Thesis (36 EC).

The courses are listed below. See for more information the website:

<http://www.math.leidenuniv.nl/statscience/>.

First semester

Course	Level	EC
Statistics and probability	400	9
Mathematics for statisticians	300	4
Introduction to life and behavioural sciences	400	5
Linear and generalized linear models and linear algebra	400	9
Statistical computing with R	400	3

Second semester

Multivariate analysis and multidimensional data analysis	500	6
Bayesian statistics	500	6
Mixed and longitudinal modeling	500	6
Survival analysis	500	6
Study design in the life and behavioural sciences	400	6

Third semester

Advanced statistical computing	500	3
Statistical learning	500	4
Psychometrics and SEM	500	6
Statistical consulting	500	5
High dimensional data analysis	500	6
Statistical genetics	500	6

Fourth semester

Internship	10
Thesis	20-26
Integrated internship+thesis	30-36

Master specialisation Mathematics and Science Based Business

The MSc programme Mathematics and Science Based Business (SBB) prepares students for a career in science-related business and administration and for innovation and enterprise from a mathematical perspective. In addition to knowledge in mathematics, students obtain competence with respect to organisations, people in organisations, and establishment and management of processes. Students with a MSc in Mathematics and Science Based Business are also admissible to a PhD programme.

In order to get a SBB Master annotation, a minimum programme consisting of the course SBB Fundamentals and the SBB training period must be completed (see below). The course SBB Fundamentals can also be taken in the “free choice” part of the research MSc programmes “Algebra, Geometry and Number theory” and “Applied Mathematics”.

QUALIFICATIONS FOR ADMISSION

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. The choice in optional courses in the MSc programme may be limited by the need to adapt the programme to the actual knowledge of the candidate.

PROGRAMME

Mathematics

The Mathematics component of the Science Based Business (SBB) specialisation consists of a research project of 40 EC in one of the research groups of the Leiden Mathematical Institute, including a Master's thesis and an oral presentation, 20 EC of courses to be selected in correspondence with the research topic, and a mathematical project connected with the SBB training period (see below).

Science Based Business

The Business-related part of the complete SBB programme consists of 40 to 60 EC of the following components:

Foundation:	Level	EC
SBB Fundamentals	400	15
Research Based Business Opportunities	400	5
Research Based Business Ventures	400	5
Research Based Business Planning	400	5

Advancement:		
RBB New Business Development	500	3
RBB Technology Transfer	500	3
SBB Management	500	3
Learning from Silicon Valley: Innovation, Entrepreneurship & Successful Cluster Development	500	10
SBB Essay	500	3-7
SBB Elective	400-600	3-15
Finishing:		
SBB Internship	600	22-35
RBB Assignment	600	22-35

See for more information on Science Based Business the following website:

<http://www.sbb.leidenuniv.nl/>

Master specialisation Mathematics and Science Communication & Society

The MSc programme Mathematics and Science Communication & Society concerns science communication in a broad sense. The Master specialisation Science Communication & Society is offered by lecturers in Science Communication & Society (SCS).

SCS closely cooperates with the MSc-specialisation „Journalistiek & Nieuwe Media“ (MSc Dutch Language and Culture, Faculty of Humanities, Leiden University).

The first year of the MSc-programme (60 EC) focuses on Mathematics. Specialisation in communication (60 EC, with a minimum of 40 EC) will be achieved in the second year.

The programme prepares students for a career in popularisation of science, for example, as a scientific writer or public relations officer. Students with a MSc in Mathematics and Education are also admissible to a PhD programme in Mathematics or in Science Communication.

QUALIFICATIONS FOR ADMISSION

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. Preferably, the BSc programme has included the 10 EC course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON) or an equivalent course. Applicants must provide proof of proficiency in Dutch.

Before participating in the MSc-specialisation „Science & Communication“ the complete programme, including electives, should be presented to the SCS-coordinator (prof. dr. Jos van den Broek and the study-coordinator of the own MSc-programme for approval.

PROGRAMME

Mathematics (60 EC)

The Mathematics component of the Communication specialisation consists of a research project of 40 EC in one of the research groups of the Leiden Mathematical Institute, including a master's thesis and an oral presentation, and 20 EC of courses to be selected in correspondence with the research topic.

Communication (60 EC)

The Communication part consists of the following components:

	Level	EC
Fundamentals of Science Communication and Society	400	17
Training Period	600	23-34
<i>Choice of</i>		
Mathematics courses	≥400	0-20
Courses in Communication	≥400	0-8
Communication Master thesis	500/600	5
Communication research project correlated to the Master thesis	500/600	4
Total		60

An internship can be done in the following areas of expertise:

Journalism, e.g. at a:

- Popular-scientific magazine
- Scientific editorial board of a newspaper
- At a scientific programme on radio or TV
- Including website content management

Museology, e.g. at a:

- Science-museum
- Scientific centre
- Zoo
- Educational programme
- Exhibitions
- Websites

Communication and Education, e.g. at a:

- Nature conservation organisation
- Agency for science-communication and education
- Educational programme's
- Materials for educational purposes

Courses in scientific communication can be taken at other universities. The minimal level of the electives is 400.

For more information on this specialisation see the website:

<http://www.science.leidenuniv.nl/index.php/scs>

Master specialisation Mathematics and Education

The MSc programme Mathematics and Education prepares students for a career in teaching Mathematics. The programme includes a 60 EC Mathematics part. Students with a MSc in Mathematics and Education are also admissible to a PhD programme.

QUALIFICATIONS FOR ADMISSION

Students from any university in The Netherlands with a BSc degree in Mathematics or with a BSc major in Mathematics will be admitted to the programme. For all other (international) candidates, the Board of Admissions will judge the equivalence of their previous training to these BSc degrees. Preferably, the BSc programme has included the 10 EC course Learning, Presentation and Communication, offered by the Leiden Graduate School of Education (ICLON) or an equivalent course. Applicants must provide proof of proficiency in Dutch.

PROGRAMME

Mathematics (60 EC)

The Mathematics component of the Education specialisation consists of a research project of 40 EC in one of the research groups of the Leiden Mathematical Institute, including a master's thesis and an oral presentation, and 20 EC of courses to be selected in correspondence with the research topic. Some of these courses may be taken from the national Mastermath programme.

Education (60 EC)

The Education option of the MSc programme Mathematics and Education is offered as a joint programme of the Faculty of Science and the Leiden School of Education (ICLON). Participants are advised to contact the ICLON during their first year.

The education programme consists of the following components:

	Level	EC
Educational Theory	300	5
Supervision of Professional Development 1	400	4
Supervision of Professional Development 2	400	3

Teaching Methodology 1	500	5
Teaching Methodology 2	500	5
Specialisation	600	8
Teaching Practice 1		15
Teaching Practice 2		15

In their specialisation, student teachers develop their competences to innovate their practice (e.g., by developing and testing instruction on a specific topic). This programme is adequate to obtain the so-called “eerste graads lesbevoegdheid” in mathematics needed for teaching at Dutch high schools.

See for more information on the specialisation Education the website:

<http://www.iclon.leidenuniv.nl/studenten/master/opleidingsvarianten.tweejarig-vakmaster.html>