

STUDY GUIDE

MATHEMATICS

and

APPLIED MATHEMATICS

2010-2011

Master Programmes

UNIVERSITY OF GRONINGEN
Faculty of Mathematics and Natural Sciences
School of Natural Science and Technology
Department of Mathematics

The information in this study guide can also be found on the Internet:

www.rug.nl/wiskunde/onderwijs

More detailed information, such as schedules of classes and examinations, can also be found through this Internet address.

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1 Introduction

The University of Groningen offers the opportunity to study Mathematics as well as Applied Mathematics. Graduates of these Master programmes are awarded the degree Master of Science (M.Sc.).

This study guide contains information on programmes, facilities, important university offices, financial matters, rules and regulations etc. for Master students in Mathematics and Applied Mathematics in the academic year 2010-2011.

Data liable to change during the academic year, such as schedules for classes and examinations, and detailed information about the contents of the courses can be found on the educational pages of the website of the Department of Mathematics:

www.rug.nl/wiskunde/onderwijs

In case of individual situations or circumstances for which this catalogue does not provide sufficient information, it is advised to consult the student counsellor.

2 Organization

2.1 Faculty of Mathematics and Natural Sciences

The Faculty of Mathematics and Natural Sciences comprises three schools, the Groningen graduate school of science and sixteen research institutes.

The schools are

- the School of Natural Sciences and Technology
- the School of Life Sciences
- the School of Computing and Cognition

The Master programmes Mathematics and Applied Mathematics are offered by the school of Natural Sciences and Technology

The research activities in mathematics and applied mathematics are united in the following research institute

- the Johann Bernoulli Institute of Mathematics and Computing Science.

For more information on this research institute see

<http://www.rug.nl/wiskunde/organisatie/bestuurenbeleid/iwi>

2.2 School of Natural Sciences and Technology

The master programmes offered by the School of Natural Sciences and Technology are Chemistry, Chemical Engineering, Physics, Applied Physics, Astronomy, Mathematics, Applied Mathematics, Industrial Engineering and Management, Energy and Environmental Sciences, and Education and Communication in Mathematics and Natural Sciences.

The board of the School of Natural Sciences and Technology is constituted as follows:

- dr. H. Hanson, chair and director
- dr. R.M. Scheek (Chemistry and Chemical Engineering)
- prof. dr. ir. E. van der Giessen (Physics and Applied Physics)
- prof. dr. R.M. Mendez (Astronomy)
- dr.ir. B.J. Kooi (Industrial Engineering and Management)
- prof. dr. G. Vegter (Mathematics and Applied Mathematics)
- W. Oosterheert (student)

For more information see

<http://www.rug.nl/fwn/onderwijs/instituten/ont>

2.3 Department of Mathematics

The department chair

- Prof. dr. G. Vegter

is member of the board of the School of Natural Science and Technology

For daily affairs the department chair is assisted by

- undergraduate coordinator, vacancy
- P.J. Kruizinga-Huisman, coordination support

Furthermore the course committee advises the (department) chair about educational affairs and the board of examiners is responsible for the good order of examinations, the approval of individual course programmes and final exams.

2.4 Board of Examiners

All faculty members (permanent scientific staff) in Mathematics and Applied Mathematics are members of the Board of Examiners for Mathematics and Applied Mathematics. The Board of Examiners monitors the conduct of examinations and verifies whether individual students have met the criteria for graduation. The Board of Examiners can also make decisions regarding exemption of courses or other parts of the curriculum and other special regulations. To deal with day-to-day matters the Board of Examiners appoints an Executive Committee and Chair from among its members:

- Prof. dr. J. Top, chairman
- Dr.ir. R.W.C.P. Verstappen, vice chairman
- P.J. Kruizinga-Huisman, secretary

For more information on the duties and powers of the board of examiners see

<http://www.rug.nl/fwn/faculteit/bestuur/examencommissies/index>

2.5 Course Committee

Matters related to the course curriculum are discussed in the Course Committee (opleidingscommissie, OC). The Course Committee has an advisory responsibility with respect to educational issues. The task of the Course Committee is to advise on matters concerning the content of course programmes, examinations, evaluation of course units and related educational issues. The Course Committee also reviews the Teaching and Examination Regulations (OER) annually.

The committee advises to the Board of School of Natural Sciences and Technology, to the Board of the Faculty, or to individual professors.

The course committee consists of four staff members and four students, but also the department chairman, the student counsellor and the undergraduate coordinator generally attend the meetings of the committee. Student members of the Course Committee are elected annually; staff members hold office for three to six years. The 2010-2011 staff members of the Course Committee are:

- Prof. dr. H. Waalkens (chair)
- Prof. dr. H.L. Trentelman
- Dr. ir. R.W.C.P. Verstappen
- Prof. dr. J. Top

and the student members of the Course Committee are:

- V.H. Schoonveld
- P.N. Meessen
- S. Jonker
- M.W. Kruithof (vice-chair)

For more information on the duties of the Course Committee see

<http://www.rug.nl/fwn/faculteit/bestuur/opleidingscommissies/index>

3 General Study Affairs

3.1 Academic calendar

The academic year of 2010-2011 starts on the 6th of September and concludes on the 15th of July 2011. The first semester is from 6 September 2009 until 13 February 2011 and the second semester from 14 February 2011 until 15 July 2011.

Resit examinations for students who have failed one or several courses of the fourth quarter of the year are scheduled in August.

For more detailed information on the academic year see

<http://www.rug.nl/fwn/onderwijs/roosters/jaarindeling>

The master courses in Mathematics and Applied Mathematics offered in Groningen (see Section 5.1) follow a division of the academic year in four periods. Each period consists of ten or eleven weeks. The first eight weeks of such a period are reserved for lectures, in the last weeks of the period the final exams are scheduled.

The master courses in Mathematics and Applied Mathematics offered by mastermath (see Section 5.2) follow the semesters.

Information on timetables can be found on the website:

<http://www.rug.nl/fwn/onderwijs/roosters/index>

3.2 Study and finances

Tuition fees

You can only apply for our Master programmes as a full-time student. The tuition fee for 2010-2011 for non-EEA students are approximately € 9500,- and for EEA students approximately € 1700,-. See

<http://www.rug.nl/studenten/inuitschrijving/collegegeld/tarieven/master20102011>

Fees do not include travel, accommodation, living and incidental costs (about 7500 euro per year). The Housing Office assists foreign students in finding accommodation.

Study expenses

The costs of books and materials for study are relatively low. For the complete master programmes Mathematics and Applied Mathematics is € 800 usually sufficient for compulsory books, lecture notes, manuals etc.

The university of Groningen has a policy on study costs. The policy aims to control costs so that the 'study cost' component does not exceed grant/loan budgets for Dutch students. The amount that students are required to spend on study materials will therefore not exceed the government grant. The standard sum for 2010-2011 is € 675,-. Each course phase has a cost 'ceiling' (standard sum x length of course).

Sometimes it is not possible to avoid going beyond the ceiling amount. In such cases it is possible to apply to the Faculty Board for reimbursement of half the extra expenditure on the basis of receipts submitted as proof. Sometimes another arrangement may be possible. Further information can be obtained from your study advisor, from the Student Service Centre and on www.rug.nl/insandouts.

3.3 Admission requirements

3.3.1 Direct admission

To be admitted to the Master programme in Mathematics or Applied Mathematics, the student must have obtained the Bachelor degree in either Mathematics or Applied Mathematics at the university of Groningen.

Holders of a Dutch or foreign Bachelor or Master degree with equivalent learning outcomes as one of these Bachelor degree programmes will also be admitted to the degree programmes.

3.3.2 Conditional admission

If the bachelor degree programme in Mathematics or Applied Mathematics at the university of Groningen is not yet completed, it is under certain conditions possible to (formally) enrol in the Mathematics or Applied Mathematics master programme.

At the request of a candidate who is preparing for the final examination for the Bachelor degree programmes in Mathematics or Applied Mathematics at the university of Groningen the Admissions Board may admit the student to the degree programme on condition that:

- 1) the student has passed the first year (propaedeutic examination) of the bachelor programme
- 2) the deficiency in the bachelor programme doesn't exceed 15 ECTS.
Modules consisting of only practicals and the final bachelor degree project may not be part of this 15 ECTS deficiency.

Conditional admission must be converted into admission within six months. In the case one or more modules cannot be re-examined in the first semester the conditional admission must be converted within a year.

3.3.3 Bridging Programme

In case a student does not meet the requirements set out in Section 3.3.1 or 3.3.2, but does hold a (HBO) Bachelor degree in a related field the student can be admitted to the master degree programme after having passed a bridging programme. This bridging programme will be an individual programme consisting of bachelor courses.

3.4 Application Procedure

3.4.1 Dutch degree holders

Holders of a Dutch degree can register and enrol for a Master degree programme at the University of Groningen via Studielink

<http://www.rug.studielink.nl>

Studielink is a national system where school leavers and students or prospective students can register or reregister at a university of higher professional education or a research university.

Once you have registered for a degree programme via Studielink, the University Student Desk of the University of Groningen will send you the following forms:

- Photo registration form (for the student card).
- Direct debit mandate form for the tuition fees.

For more information about this application procedure see

<http://www.rug.nl/studenten/inuitschrijving/inschrijven/master>

3.4.2 International students and Dutch students with a foreign certificate

Application

If you have a foreign certificate and want to be admitted to the Master degree programme in Mathematics or Applied Mathematics at the University of Groningen, you apply for admission at the online application system of the University of Groningen via Studielink

<http://www.rug.studielink.nl>

Admission

After applying via Studielink you have to go through an admission procedure in which the Admission Board of the Mathematics and Applied Mathematics programme, based on the information provided by you, decides whether or not you meet the admission requirements. For this procedure the University of Groningen offers its online admission system (OAS)

For international students applications for admission to the MSc-programme in Mathematics or Applied Mathematics should be completed in OAS as soon as possible, but should have reached the university admissions office (Mrs. G.A. Sanders) before April 15th for non EEA-student and before June 1st for EEA-students.

Registration

After the admission board has decided that you are eligible for entry you have to finalize your official registration. You will receive

- an email requesting you to complete 'section 7: payment details' in studielink. Here you indicate how you are going to pay your tuition fee,
- a photo registration form (for the student card).

For more information on the procedure see

<http://www.rug.nl/prospectivestudents/application/applicationprocedure>

3.5 Information channels

Website of the department

The website

<http://www.rug.nl/wiskunde>

contains a fount of information about education and research. The information behind the button 'Education' (Onderwijs) does not only give you information from this catalogue, but also the latest detailed information on (examination) timetables.

E-Mail

In some cases messages of importance to students or groups of students, like requests to sign up for certain courses or alterations in the rosters, are sent to the electronic mailbox of the concerned students (see Section 4.4.2). The students are for this reason expected to check their mailbox on a regular base.

Nestor

Nestor/Blackboard (Nestor, for short) is the electronic learning environment (ELO) of the University of Groningen (see also Section 4.4.4). Nestor is used in courses to provide supporting information for lectures such as study guides, lecture notes, sheets used during lectures, assignments and other documents.

ProgresWWW

ProgressWWW is a web application designed for students to access their course results and register for courses and exams (see also Section 4.4.3). The course results are refreshed several times a week; a few days after the final grade has been registered by the administrations office, the grade will also appear on ProgressWWW.

Notice board

Examination results are also announced on the notice board in front of the office of the Bureau of Education and Exams (Bureau Onderwijs & Examens) room 5111.0077.

University paper (Universiteitskrant, UK)

The Executive Board (College van Bestuur) frequently publishes the central rules and regulations in this paper. This mainly concerns tuition fees, scholarships and the graduation fund. Furthermore, the UK contains columns with announcements of departments of the faculty of Mathematics and Natural Sciences among those of other faculties. The weekly issue of the UK can be found in the entrance hall of the various buildings.

3.6 Student counsellor

The main task of the student counsellor is to provide assistance to students experiencing personal and academic problems. In practice, issues such as choice of courses, study methods, choice of (future) specialization, optional courses and career perspectives are most discussed. A student counsellor can also provide assistance or help in financial matters (for instance in case of delay) or personal issues. The student counsellor for Mathematics and Applied Mathematics can be reached by mail, studieadviseur.wiskunde@rug.nl

3.7 Bureau of Education and Exams

Study results are processed by the *Bureau of Education and Exams* (room number 5111.0077, email: boenb4@rug.nl) and will be published on the bulletin board opposite to room 5111.0077. Students can look at their achieved results through ProgressWWW (www.progresswww.nl/rug/).

At least once a year all students receive a certified printout of their results.

In case an official list of results is needed in between, a certified list of results can be obtained from the Bureau of Education and Exams.

3.8 Studying Abroad

All Master students are in principle eligible to studying abroad.

What are the possibilities?

- Following courses at a foreign university
The University of Groningen has exchange agreements with a number of foreign universities, which means that no fees will be raised if Groningen students visit for a mobility period.
For more information see

<http://www.rug.nl/wiskunde/informatievoor/exchangestudents>

- Doing a research project at a foreign university
Generally this should be done in a research group abroad with existing ties with the research group in which you are doing your final research project. Contact your thesis supervisor for the possibilities.
- Doing an internship in a company abroad.

Financing the study or internship abroad

There is a number of programmes to finance your study or internship, such as

- Socrates/Erasmus for study at a university within the EU,
- Marco Polo for all other destinations and for travel expenses for internships, in case these are not paid for by the company.
- Groninger Universitair Fonds (GUF).

Important websites for general information and how to finance your study or internship are

- www.wilweg.nl
- www.nuffic.nl
- www.beursopener.nl

Contact your student counsellor (see Section 3.6) for more information.

3.9 Teaching Assistant Ship

As a senior student, you have the opportunity to gain valuable experience as a teaching assistant. Teaching assistants mainly teach exercise classes or assist during computer sessions or practicals. Also, grading homework or exams are part often part of a teaching assistant ship. Of course the teaching assistant is paid for his services.

Students interested in a teaching assistant ship can gain more information from the student counsellor.

3.10 Mathematics Colloquium

Every Tuesday from 16:15 until 17:30 a colloquium is organized in which scientific researchers will tell about their scientific results. These colloquia can be of interest to students as well. They will give an overview of the various research areas. During holidays and exam periods no colloquia are organized.

Coordinator: prof. dr. A.C.D. van Enter, dr. M.E. Dür

3.11 Student Organizations

Below you find a profile of the 'Fysisch Mathematische Faculteitsvereniging' (FMF) (for students in (applied) mathematics, (applied) physics and astronomy) and the Wiskunde Overleg Commissie (WOC) (for (applied) mathematics students).

Fysisch-Mathematische Faculteitsvereniging (FMF)



The FMF is the student association for students in (Applied) Physics, Astronomy, (Applied) Mathematics and Computer Science. The FMF organizes several formal activities as well as informal activities such as parties and sports events. Every month the FMF organizes a free cinema and informal drinks. As a member of the FMF you receive the magazine 'Periodiek' five times a year.

The FMF also organizes study related activities; colloquia, talks, seminars and studytrips. In 2008-2009 the FMF has organized a 3-week study trip to Argentina and Brasil and in 2009-2010 a short one and a half week foreign excursion (Kleine Buitenlandse Excursie, KBE) to Hungary where a group of about 25 students visited local companies and universities as well as cultural activities. In 2010-2011 a 3-week excursion (Grote Buitenlandse Excursie, GBE) to Australia will be organized.

The FMF has two rooms in the physics/chemistry building (Nijenborgh 4). The board of the FMF is available in room 5111.0053 daily. Furthermore the FMF has a room in which their committees can work, 5113.0101

Fysisch-Mathematische Faculteitsvereniging

Office: Nijenborgh 4 - room 5111.0053

Tel.: 050 - 363 4155/4948

E-mail: bestuur@fmf.nl

Internet: <http://www.fmf.nl>

Wiskunde Overleg Commissie (WOC)

The Wiskunde Overleg Commissie (WOC) meets on a regular basis, and gives (applied) mathematics students the opportunity to make their voice heard. Students can express their remarks, complaints and ideas about for instance the schedules, exams, lecturers, courses, and other educational issues to the WOC. The student representatives of the course committee (OC, see Section 2.5) or the board of the school of natural sciences and technology (see

Section 2.2) can pass this information on to the appropriate committees. The meetings of the WOC are announced by mail and on the notice boards of the Bernoulliborg. You can reach the WOC by mail: woc@rug.nl.

3.12 Examinations

Timetable

The examination timetables give the dates for written examinations of the individual courses:

<http://www.rug.nl/wiskunde/onderwijs/roosters/index>

Usually an examination is scheduled at the end of the quarter in which the course has been offered. Students are allowed to take the examination of a particular course unit two times per year.

The timetables of examinations are liable to change, so students should check the website regularly.

Enrolment for examinations

Students should enrol for written exams through ProgressWWW

<http://progresswww.nl/rug/>

at least three days before the examination date. The work of student who did not enrol for an exam will not be marked. If you cannot take part after all, you can cancel the enrolment until one day before the examination date.

Procedures during exams

Students are required to show their student card at written exams.

Graphing calculators are not permitted unless such is explicitly allowed by the lecturer of the course. Electronic pocket calculators without graphic display are allowed.

Students are obliged to follow the directions of the vigilance personnel.

Fraud

Any act of a student to mislead the examiner in such a way that a correct evaluation of the students knowledge, insight or competences is prevented, is considered as fraud.

Examples of fraud are:

- the use of crib notes (on paper or digital);
- plagiarism (also the use of internet files without proper reference is considered as fraud);
- 'free riding' on the work of fellow students in group assignments;
- copying (laboratory) reports from fellow students;
- falsifying experimental data;

In case of fraud the Board of Examiners can exclude a student from participating in the particular exam for a period of one year.

3.13 Final research project

Students can carry out the Master research project in one of the research groups in (Applied) Mathematics. For an overview of the research groups we refer to the following website:

<http://www.rug.nl/wiskunde/onderzoek/programmas>

The research project can be conducted as an internship at a research department of an industrial company or academic department as well. For applied mathematics students an internship of at least 15 ECTS is an obligatory part of the research project.

A protocol for the research project can be found at

Choosing a subject

The student should contact a member of the research group of his preference in time, in order to have sufficient time to decide in mutual consultation upon a subject for the research project.

Co-advisor (Coreferent)

The Master research project is assessed by the thesis advisor as well as a *co-advisor*. The co-advisor is a faculty member from a group other than that in which the research is conducted, or in case of an internship an external supervisor. The name of the co-advisor will be mentioned in the Master thesis.

Written and oral presentation

The student writes a thesis on the research conducted in the project and gives a final oral presentation on the subject matter. An electronic version of the Master thesis must be sent to Mrs. P.J. Kruizinga-Huisman (room 5114.0016, p.j.kruizinga-huisman@rug.nl).

It is advised to make an appointment (and announcement) for an oral presentation of the Master thesis in time. Appointments should be made in concordance with the supervisor. Reservations for a lecture-room can be made at Mrs. Kruizinga. About a week before the oral presentation you should send an abstract and title of your presentation to Mrs. Kruizinga, who will send an announcement to the staff members and students.

Evaluation forms

At the start, halfway and at the end of the research project information has to be laid down in forms. At the start of the research project the student, in consultation with his advisors, makes a short description of the project and a global planning for the period of research. Halfway the period of research the student and advisors evaluate the course of events so far. At the end of the research project the advisors give a final judgement of the work of the student based on the following aspects: the student's scientific input, the quality of the (software) product, and the quality of the written and oral presentation. The forms can be downloaded from

<http://www.rug.nl/wiskunde/onderwijs/afstudeeronderzoek/begeleidingsformulier>

and have to be handed in at Mrs. Kruizinga.

3.14 Approval of master programme

A student graduates on an individual programme, which has to be approved by the Board of Examiners. This programme has to meet the requirements of the master programme in mathematics or applied mathematics (see Chapters 5 and 6). To avoid delay it is advised to ask the approval of the Board of Examiners immediately after starting the master programme in mathematics or applied mathematics. For help on composing the programme the student can turn to the student counsellor (see Section 3.6). Before filing the programme to the Board of Examiners it has to be authorized by either the student counsellor or the first advisor of the master research project.

The form for filing the programme can be downloaded from:

<http://www.rug.nl/wiskunde/onderwijs/examens/studieprogrammaDownloaden>

and has to be handed in at Mrs. P.J. Kruizinga-Huisman (room 5114.0016, p.j.kruizinga-huisman@rug.nl), after which the student receives notice about the approval within 8 weeks. On the form a student specifies both the name and specialization of the master programme, for instance master Mathematics with specialization Algebra and Geometry, P-variant and the names of the modules.

When a student wishes to make changes to an already approved programme, the programme has to be presented to the Board of Examiners once again.

3.15 Transfer Regulations

The master programme will be decided on every year. If the new programme differs from the programme that was valid until that year, a transfer regulation will be made for the students who did not finish the old programme yet. In case the transfer regulation is not sufficient, a student should turn to the student counsellor as soon as possible.

3.16 Procedure for Graduation

Enrolment procedure for graduation

1. In order to submit a request for graduation a student needs to have an approved programme (see Section 3.14). Furthermore a student must have passed all course units of this approved programme. An exception to this rule is made when submitting a request for graduation in June. In this month the results from the exams in June/July and August and the master research project can still be missing.

2. Request for graduation

At least one month before the date of the graduation ceremony, the student has to submit personally a request for graduation. Every first Monday of the month from 9:00 until 12:00, except in July, August and September, this can be done in the office of Mrs. P.J. Kruizinga-Huisman (room 5114.0016). Only in case of urgent reasons an exception will be made, and a student is allowed to make an appointment to submit a request for graduation at a different time. When submitting the request for graduation the student should bring the approved master programme, and an officially signed print-out of the results in progress.

Graduation ceremony

The graduation ceremony usually takes place in the Academieggebouw, Broerstraat 5. After proper registration the student will receive a schedule with time and place of the ceremony. At the graduation ceremony the graduate receives a graduation certificate together with a diploma supplement stating the grades on the separate course units.

Usually the graduation date (= the date on the graduation certificate) coincides with the date of the graduation ceremony. In some cases (usually around September 1st) the graduation ceremony may be postponed to some later date. This may be the case when the last examination results are obtained in the last weeks of August and the administrative procedures for graduation cannot be timely fulfilled before August 31st (i.e. before the end of the academic year). When the examination results do so permit, the graduation date can be set at August 31st, whereas the graduation ceremony takes place in September.

Dates of graduation ceremonies

September 20, 2010
December 13, 2010
March 14, 2011
June 6, 2011
September 19, 2011

For more information see

<http://www.rug.nl/wiskunde/onderwijs/examens>

3.17 Objection and appeal procedures

Mistakes are, unfortunately, sometimes made when applying rules and regulations. This is why the Students' Charter (Studentenstatuut) covers provisions to ensure lawful protection of the student. If students feel unjustly treated, they can object and lodge an appeal.

The two agencies a student can contact are mentioned in the Students' Charter:

- Higher Education Appeals Tribunal (College van Beroep voor het Hoger Onderwijs). For most matters concerning the central part of the Students' Charter (see Chapter 9).

- Examination Appeals Board (College van Beroep voor de Examens). Mostly for matters concerning the decentral part of the Students' Charter (OER).

An overview of all objects and appeal procedures can be acquired at STAG. Interested persons can also contact the "Dienst Algemeen Bestuurlijke en Juridische Zaken" of RuG, tel. 363 5440.

Complaints

There are many situations possible where regulations of the Students' Charter (Studentenstatuut) are not directly violated, but that make the student still feel improperly or unjustly treated. In such a case he/she can file a complaint to the following agencies:

Decentral

Each of the faculties and departments has its own (specific) complaint procedure. The study counsellor can offer direct assistance, but he/she could also forward the case to, for example, the head of the Course Committee (Opleidingscommissie), a member of the Faculty Board (Faculteitsbestuur) or the dean.

University Student Desk

If one cannot or wishes not to contact the faculty or department, the complaint could be discussed with a student dean at University Student Desk. He/she will act as ombudsman and mediate, and, if requested, demand inspection of dossiers or contact professionals.

4 Facilities

4.1 The University Student Desk

The University Student Desk (USD) is the walking encyclopedia of the University of Groningen. You will get a concrete answer to your question or you will be send to the right person, department or organization. The staff of the USD is specialized in answering questions about:

- admission and application;
- registration and deregistration;
- conflicts, complaints and lodging an appeal or objection;
- studying with a disability;
- choosing a degree programme;
- study grant from DUO;
- study delay and Graduation Fund.

You can also consult the knowledge base at www.rug.nl/insandouts if you have questions about these or other issues.

You can find the contact details and opening hours of the USD at: <http://www.rug.nl/usd>

4.2 The Student Service Centre

Students can go to the Student Service Centre (SSC) for all support issues where the answer from the degree programme is or may be insufficient. The SSC offers training programmes and courses and workshops in the field of study skills. You can also consult a student psychologist or a student counsellor.

Our **student counsellors** specialize in dealing with financial matters, registration and deregistration, fixed intake programmes, study choice, studying with a performance disability and complaints and appeal procedures. In the event of study delay of more than 15 ECTS credit points due to extraordinary circumstances, it is essential to make an appointment with a student counsellor in order to qualify for support from the Graduation Fund. Don't delay, arrange it today! More information can be found on:

www.rug.nl/studievertraging

Our **student psychologists** can help with problems relating to matters such as studying, social contacts, relationship with parents, making decisions, stress and anxiety, depression and assertiveness problems. Support is provided in the form of a short series of individual sessions. Group activities, such as assertiveness training and short series of group therapy sessions, are also offered.

The SSC has a wide range of **training programmes**, courses and workshops in the field of studying successfully and personal development. They include developing academic writing skills, effective studying and coping with fear of failure or stress. You can find more information about our range on www.rug.nl/ssc

You can also consult the knowledge base at www.rug.nl/insandouts if you have questions about these or other issues. If you do not find an answer to your question, just click the contact button to send an e-mail.

You can find the contact details and opening hours of the SSC at:

<http://www.rug.nl/ssc>

4.3 Central Departments

4.3.1 Study affairs related addresses

Student Service Desk

Visiting address: Broerstraat 5

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 8004

Internet/e-mail: www.rug.nl/hoezithet, www.rug.nl/insandouts

International Service Desk (ISD)

Visiting address: Broerstraat 5

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 8181

E-mail: isd@rug.nl

Internet: www.rug.nl/isd

Student Counsellors, a department of the Student Service Center

Visiting address: Uurwerkersgang 10

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 8004

Internet/e-mail: www.rug.nl/ssc

Psychological Counselling Service, a department of the Student Service Center

Visiting address: Uurwerkersgang 10

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 5544

E-mail: studentenpsychologen@rug.nl

Internet: www.rug.nl/ssc

Centre for Study Support and Academic Skills (SO), a department of the Student Service Center

Visiting address: Uurwerkersgang 10

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 5548

E-mail: y.m.robert@rug.nl

Internet: www.rug.nl/ssc

Talent and Career Center (T&CC)

Visiting address: Munnekeholm 2, 9711 JA Groningen

Postal address: P.O. Box 7117, 9701 JC Groningen, the Netherlands

Telephone: (050) 311 1589

E-mail: info@talentcareercenter.nl

Internet: www.talentcareercenter.nl

Board of Appeal for Examinations (CBE)

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 5439

University Funds Committee (UFC)

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

E-mail: ufc@rug.nl

Other facilities

- University Sports Centre, Blauwborgje 16, tel. (050) 363 80 63;
- ACLO Student Sport Foundation, Blauwborgje 16, tel. (050) 363 4641, www.aclosport.nl
- USVA Student Cultural Centre, Munnekeholm 10, tel. (050) 363 4670, www.usva.nl
- GSP *Groninger Studentenplatform* (student platform), Kraneweg 33, tel. (050) 312 9926, www.gspweb.nl

Student representatives

Student interests are represented by the following student factions in the University Council:

- GSb (*Groninger Studentenbond*: Groningen student union), tel. (050)363 46 75, www.groningerstudentenbond.nl
- SOG (*Studenten Organisatie Groningen*: student organization), tel. (050)363 77 13, www.studentenorganisatie.nl;
- Lijst Calimero, e-mail: contact@lijstcalimero.nl, www.lijstcalimero.nl.
Visiting address and postal address for all these organizations: St. Walburgstraat 22, 9712 HX Groningen.

4.3.2 General addresses

Board of the University (CvB)

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 5285

University Council (U-raad)

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 8535

E-mail: uraad@rug.nl

Internet: www.rug.nl/uraad

Legal Affairs Office (ABJZ)

Postal address: P.O. Box 72, 9700 AB Groningen, the Netherlands

Telephone: (050) 363 5440

E-mail: abjz@rug.nl

Internet: www.rug.nl/bureau/expertisecentra/abjz

Donald Smits Center for Information Technology (CIT)

Visiting address: Zernikeborg, Nettelbosje 1

Postal address: P.O. Box 11044, 9700 CA Groningen, the Netherlands

Telephone: (050) 363 9200

E-mail: secretariaat-cit@rug.nl

Internet: www.rug.nl/cit

CIT Helpdesk:

Telephone: (050) 363 3232

E-mail: servicedesk-centraal@rug.nl

Health, Safety and Environment Service (AMD)

Visiting address and postal address: Visserstraat 49, 9712 CT Groningen, the Netherlands

Telephone: (050) 363 5551

E-mail: amd@rug.nl

Internet: www.rug.nl/amd

Office of the Confidential Advisor

Marijke Dam, Confidential Advisor

Visiting and postal address: Visserstraat 47, 9712 CT Groningen, the Netherlands

Telephone: (050) 363 5435

E-mail: j.m.dam@rug.nl

Internet: www.rug.nl/vertrouwenspersoon

Complaints Committee for harassment, sexual harassment and aggressive, violent or discriminatory behaviour

Postal address: Antwoordnummer 172, 9700 AB Groningen

4.4 Computer facilities

4.4.1 Account

At your enrolment you will receive a student number and an account. This student-account gives you access to four applications. The four applications are login on the computers with access to the Internet and storing data; e-mail; Nestor (the electronic learning environment of the Rijksuniversiteit Groningen); and ProgressWWW where you can enrol in courses and where you can find your study progress. Your login name is made up of your student number preceded by an s (the s of student). Your initial password will be sent in a letter. On <http://progresswww.nl/wachtwoord/> you can alter your password.

4.4.2 E-mail

Your student e-mail address is the primary means of communication of the university and the faculty for news and information about your study.

Use a browser (like Internet Explorer) and go to

<https://student.rug.nl/>

to access your email. Your e-mail address is both your login name (s[student number]@student.rug.nl) and your name [initials separated by periods].[infix].[surname]@student.rug.nl.

4.4.3 ProgressWWW

ProgressWWW is a web application designed for students to access their course results and register for courses and exams

<http://progresswww.nl/rug>

The course results are refreshed several times a week; a few days after the final grade has been registered by the administrations office, the grade will also appear on ProgressWWW. If you need an official transcript (grade report), you can print the course results and ask the administrations office for a stamp and signature.

4.4.4 Nestor/Blackboard

Nestor/Blackboard (Nestor, for short) is the electronic learning environment (ELO) of the University of Groningen.

<http://nestor.rug.nl>

Blackboard, ProgressWWW and the Course Catalogue system OCASYS provide supporting information for lectures such as study guides, lecture notes, sheets used during lectures, assignments and other documents. Blackboard contains a 'Discussion Board', a forum used by students to exchange information and a 'Drop Box', to share files with fellow students such as a group assignment that has to be reviewed by students in your group.

When enrolled, a student is assigned a university e-mail address, a login name and a password. This login name and password grants access to the University Webmail, Nestor and ProgressWWW.

4.4.5 Ocasys

Ocasys is the university course catalogue

www.rug.nl/ocasys

It contains short descriptions of course contents, necessary literature, etc.

4.4.6 Student PCs

Nijenborgh 9 (Bernoulliborg) has four computer rooms for (applied) mathematics and computing science on the second floor (5161.0204, 5161.0207, 5161.0208, 5161.0216) with around 60 computers. These computers have a dual boot: with your central student account you can login onto the windows faculty network, with a special account you can login onto the Linux network of the mathematics and computer science department. The library in the Bernoulliborg has 67 studyplaces with PC. With these PCs you can log with your student-account onto the faculty network.

Nijenborgh 4 (NCC) has five computer rooms (5116.0310, 5116.0303 and 5116.0315, 5113.0303, 5113.0306, 5111.0010) with around 90 computers for all students. Using these PCs you can log with your student-account onto the faculty network. You will then have access to applications, your own data on the home directory (X:\) and the Internet. Some of the rooms are used for practicals and courses, but when these are not scheduled you can use the room for self-education. Two printers are accessible for students (in 5116.0308 and 5113.0303).

4.4.7 Servicedesk

The Service Desk is part of the Donald Smits Center for IT (CIT, <http://www.rug.nl/cit>) and supports employees and students at the University of Groningen if they have questions or problems in the field of IT. Support is mainly given via the phone, mail or the website. In addition, at various locations within the University there are desks where Service Desk staff carry out their activities.

Servicedesk Nijenborgh 4 (NCC)

Telephone: (050) 363 4341

Room: 5116.0308

E-mail: servicedesk.zernike@rug.nl;

Opening hours: Monday-Friday 8.30 - 17.00 hours

Servicedesk Nijenborgh 9 (Bernoulliborg)

Telephone: (050) 363 8100

Room: 5161.0257

E-mail: servicedesk.zernike@rug.nl;

Opening hours: Monday-Friday 8.30 - 17.00 hours

If your nearest Service Desk is closed, please contact the central service desk:

(050) 363 3232, servicedesk.centraal@rug.nl (Monday- Friday 8.30 – 22.00 hours; Saturday 10.00 – 18.00 hours).

4.4.8 Computerscreens and RSI

Many students spend a lot of time in front of computers and are at risk of developing RSI-troubles. RSI is the abbreviation for Repetitive Strain Injury and is a generic term for all troubles involving neck, shoulders, arms, wrists and hands. These troubles can become chronic and lead to incapacitation for work and serious limitations in everyday life.

Symptoms

RSI symptoms can vary from stiffness, pain and tingling sensations to loss of strength in above mentioned body parts. Initially the symptoms occur only during work in front of screens, but at

a later stage they occur also when at rest. Eventually the troubles might occur continuously, causing pain at even the simplest of actions or making them completely impossible.

How to prevent RSI?

There is no standard solution to preventing RSI. The measures you could take have mostly all to do with relaxation of muscles and mind, and stimulation of blood flow.

Looking at the risks for developing RSI, we fully have to consider five points, the so-called 5W-approach.

Workload

- Make actual planning and prevent peak hours
- If necessary, take the course "Effectief Studeren" at the study support bureau (Bureau Studie Ondersteuning, <http://www.rug.nl/so>)
- Realize your productivity is higher when taking a regular break than when working on end
- Try to put things into perspective; it helps you avoiding working too long on end and it stimulates regular breaks and it makes you unwind
- If you don't feel on top of the world, drop by the study counsellor, student counsellor or student psychologist.

Work organization

- Incorporate as much variation in your work as possible: reading, writing, typing, using Internet. Also vary easy and difficult tasks
- Use the shortcut keys on your keyboard more frequently than your mouse
- Make regular breaks
- Raise the alarm over too many deadlines or too many writing assignments at the same time.

Working hours

- Don't work more than five or six hours on your computer a day. Don't forget to count the hours of gaming and using Internet. Special software is developed to remind you of taking breaks
- Take regular breaks: a minimum break of ten minutes every two hours of working in front of a screen.

Workplace

- Put the screen right in front of you, not too close. Prevent having to work with a turned neck. Make sure the top of the screen is at eyes' height. Prevent annoying reflections from windows. Use large font sizes, so you don't have to bend over to read the letters
- You need a good chair of which the height, back and arm rests are adjustable. The back of the chair should mainly provide support to you lower back's cavity. Arm rests relieve the shoulders. Adjust them in such a way that the upper arms loosely touch them and form a right angle with your forearms
- If necessary, search further on the Internet how to kit out your workplace
- Report bad computer workplaces at the Environment- and Occupational Health & Safety Act coordinator (Arbo- en milieucoordinator)
- Never work longer than two hours a day on a laptop. Connect an unattached keyboard and mouse to your notebook, and place the screen at eyes' height
- Make sure you have a good working place at home.

Way of working

- See to it that you have a good physical condition
- Sit upright and make sure there's a right angle between your upper and lower legs when your feet are flat on the ground
- Keep your wrists stretched when striking the keys and using the mouse
- Perform regular physical exercises during work on the computer.

Lastly...

- Drink a lot of water (the resulting visits to the toilet make natural breaks)

- Take early troubles seriously and check the risks applicable to your situation and find a solution. Do not ignore your body's warning signals
- If necessary, visit your family doctor or the physiotherapist at your sports centre.
- A lot of information about RSI can be found on the Internet
- For further questions or advice, contact the Environment- and Occupational Health & Safety Act coordinator (Arbo- en milieucoördinator), ing. Andrys C.D. Weitenberg, room 311 in the Bernoulliborg, e-mail a.c.d.weitenberg@rug.nl, tel. 050 363 4618.

4.5 Library

4.5.1 Library of Faculty of Mathematics and Natural Sciences

Library facilities

The scientific information services of the Rijksuniversiteit Groningen are being looked after by a library organization composed of about ten faculty libraries and the University library (Universiteitsbibliotheek, UB). The aim of the university libraries is the support of scientific research and education by means of an optimal provision of services concerning scientific information. This includes many university wide electronic subscriptions on magazines, (conference) reports, etc.

The library of the Faculty of Mathematics and Natural Sciences (Library FWN) serves research and education of staff and students of of FWN. Furthermore, the Library FWN is open to all staff of the Rijksuniversiteit Groningen, to all students associated with the university and all guests at the library.

The FWN library is located at:

- Library FWN
Opening hours: Monday-Friday, 9.00 - 17.00 hours
Address: Bernoulliborg, Nijenborgh 9, 9747 AG Groningen

Library card

Staff can apply for a library card at the library. Students can use their student card as a library card.

Borrowing

Books will be out on loan for a period of four weeks. Bibliographies, reference books (like encyclopaedias, manuals and dictionaries) and magazines will not be lent out as a rule.

Practical information

Library FWN

Telephone:	050 – 363 4126 (loan- and information counter)
Fax:	050 – 363 6875
E-mail:	bibliotheekfwn@rug.nl
Website:	http://www.rug.nl/bibliotheek/locaties/bibFWN
Study places with pc	67
Study places without pc	41
Study cabinets	6 (3 with pc, for 2 to 4 persons)

Copiers are placed at the ground and first floor. Copy cards are available at the library counter. A scanner is placed at the first floor. It is possible to use one's own laptop in the library.

If you want to consult electronic journals or databases from outside the RUG, you may be prompted to log on to the Proxy Server, through which you will then be able to access the journal. The Proxy Server of the RUG libraries offers safe, authorized access from outside the RUG to (bibliographical) databases and electronic journals under licence – from any computer in the world.

You will need a user name and password to log in to the Proxy Server. Students can log in using the computer account they received when registering at the university. This means that you log into the Proxy Server using the same log-in data you use for Nestor, Webmail and ProGRESS-WWW (your user name is your student number preceded by an "s").

4.5.2 University Library (UB)

The library organization Groningen has, apart from several faculty and institutional libraries, also the (central) University Library (UB). The UB functions as facility centre for the entire university community; for both the faculty- and institutional libraries and the library users. The UB offers students many services. It contains around 1600 places to study. Furthermore, the library holds vast collections of references and educational material. Of these about 30% is available at the study rooms. The remaining material is kept at closed depots. The material can be accessed via the loan institution.

For further information and services of the UB one may refer to the website:

<http://www.rug.nl/bibliotheek/index>

5 Master Programme Mathematics

5.1 Introduction

How does a bank check whether your digital signature is a valid one? Do the planets move in stable orbits or will they eventually collide? How can, within the three-dimensional figures, a 3D-sphere be characterized? The mathematics behind these questions is dealt with in the Master degree programme in Mathematics.

The master programme in Mathematics comprises two years of full time study, equivalent to 120 ECTS. To be admitted to the Master programme in Mathematics, the student must have obtained the prerequisite Bachelor degree in Mathematics or Applied Mathematics.

Our master programme Mathematics has four specializations:

- Algebra and Geometry
- Dynamical Systems and Analysis
- Statistics and Probability
- Science, Business and Policy (M-variant)

The first three specializations are all a P-variant. The goal of a P-variant is to prepare for a PhD study. The specializations of the P-variant focus on research.

The specialization Science, Business and Policy (Bèta, Bedrijf en Beleid) is an M-variant (M stands for maatschappij which means society), and is offered as a variant of almost every Master degree programme of the faculty of mathematics and natural sciences. This specialization can be chosen by students who would like to have a career in business or government. Approximately one year is devoted to general knowledge within the field of the master study (i.e. mathematics) and one year is devoted to management and industry.

The master programme Mathematics consists not only of courses offered locally in Groningen (see Section 7.1), but also of courses offered by Mastermath (the cooperation of the mathematics departments of the Dutch universities, see Section 7.2).

5.2 Objective

The objective of the Mathematics master programme is to teach a student the mathematical knowledge, the skills, and attitude needed to pursue a professional (research) career. The student will gain specialized mathematical knowledge in selected areas such as algebra and geometry, dynamical systems and analysis, probability theory and statistics. Furthermore, the student will learn how to solve a problem by using abstraction and modeling, to look for scientific literature on the subject, and to determine whether the problem can be solved by using existing mathematical theory or new theory should be developed. Finally, the student will learn how to present mathematical results in a written and oral form, both for a specialized and general audience.

5.3 Specializations

5.3.1 Algebra and Geometry (P-variant)

Algebra

Central topics in the Algebra track are algebraic geometry, number theory, and representation theory. Algebraic geometry deals with the zeros of a set of polynomial equations in several variables. Questions involve the dimension of such a set; whether or not it can be

parametrized in terms of rational functions; in case the polynomials have coefficients in a finite field, counting the number of points over that field; more generally, describing the points with coordinates in a given field. Special cases like elliptic curves and hyperelliptic curves and various kinds of surfaces have applications in Coding theory, Cryptography, Computational Geometry and more. Number theory discusses integers and prime numbers and generalizations of these concepts, from an algebraic points of view but also from a complex analytic point of view. Representation theory is an important tool in studying groups and especially Galois groups. The theory has many applications ranging from theoretical physics and chemistry to number theory and (algebraic) geometry. Basically, representation theory studies groups by considering their images in groups of invertible matrices.

Geometry

Differential Geometry and Topology, in particular Morse Theory and Singularity Theory, and their applications are central topics in the Geometry track. Geometric approximation deals with the approximation of shapes by 'simple' geometric objects, like polyhedral objects or piecewise quadratic surfaces. The objective is to guarantee correct topology of the approximated object, and to obtain good approximation of first and second order differential invariants like normals and curvatures. An important issue is the complexity of the approximating geometric object in terms of intrinsic geometric invariants of the shape to be approximated, like Euclidean or affine curvature. These results have direct implications for the design of efficient approximation algorithms. Joint research with astronomers focuses on the detection of structure in large cosmological data sets, using methods from Morse Theory. Geometric structures, like walls and filaments, can also be described as caustics of the matter density field, which creates a link to Singularity Theory.

People

Prof.dr. J.Top: Algebra

Prof.dr. G.Vegter: Geometry

5.3.2 Dynamical Systems and Analysis (P-variant)

Dynamical Systems provides the background mathematics for systems that evolve in time. On the one hand you can think of mechanical contraptions like a pendulum or a spring, or the solar system, etc., but on the other hand also on the population sizes in a predator prey setting, modelling aspects of evolution of the climate or the world economy. The theory combines aspects of pure and applied mathematics. In the first place it uses theory of ordinary differential equations and many other issues from calculus and analysis. In the second place it also uses geometrical, topological and measure theoretical tools. One of the central issues is that of chaotic dynamics, which expresses a certain unpredictability notwithstanding the fact that the system has a deterministic dynamics.

Mathematical Physics is a wide area in between mathematics and theoretical physics, which has a large overlap with Dynamical Systems. This does not only refer to the many moving systems in classical mechanics, but also to systems with infinitely many particles, like in Statistical Mechanics, or to partial differential equations and the like.

Analysis is such a basic part of the background theory, that many issues from Dynamical Systems also touch upon developments in Analysis. One may think of theorems guaranteeing the existence of invariant manifolds or of the singularity theory that lies at the basis of many more geometrical considerations.

People

Prof. dr H.W. Broer: Dynamical Systems, transitions between orderly and chaotic dynamics, with a focus on the occurrence of multi-periodic dynamics. This combines fundamental tools from analysis, topology and measure theory.

Prof. dr A.C.D. van Enter: Lattice Statistical Mechanics and thermodynamic formalism. This includes stochastic methods in many particle systems.

Prof. dr A.J. van der Schaft: Systems and Control Theory and Applied Analysis.

Prof. dr.ir H.S.V. de Snoo: Fundamental problems in Operator Theory. Part of this theory has interpretations in Mathematical Physics and Control Theory.

Prof. dr E.A. Verbitskiy: Lattice Statistical Mechanics and thermodynamic formalism.

Prof. dr H. Waalkens: Theoretic and application oriented aspects of Hamiltonian Dynamical Systems. This includes the topology of torus bundles in integrable systems with applications to quantum monodromy.

5.3.3 Statistics and Probability (P-variant)

Probability theory is an axiomatic description of the world, i.e. the sample space, in terms of a measure of size one. This simple definition leads to a wonderfully intricate picture, in which sometimes our intuitions about chance are neatly confirmed and other times the results completely baffle us. In general, probability theory starts by positing a probability measure and then makes statements about individual events. Statistics is sometimes referred to as "reverse engineering", in the sense that it reverses the way probability theory looks at things: statistics starts by looking at individual events and then tries to infer which probability measure was used to generate these events. In order to do justice to the structure of the data as well as to the principle of parsimony, statistics concentrates on families of probability measures, defined as a statistical model, such as a linear regression model for continuous data, a mixed effect model for longitudinal data, etc.

Both probability and statistics have a variety of application areas: stochastic simulations are crucial in climate models and the study of complex events, such as forest fires. Examples include the percolation model and the contact model, being models respectively for a disordered medium and the spread of epidemics. These systems give insight into the behaviour of models for ferromagnetism, such as the Ising and Potts models. They also provide a host of really captivating and well motivated problems in probability. Statistics, as usual, is at the flip-side of such an approach. It can use those models in combination with data to make statements about whether it is likely that climate change is man-made, whether the HIV virus can be stopped in its tracks or what a likely casualty count is as a result of the invasion in Iraq.

People

Prof E. Wit: Statistical Genomics

Statistical methodology has always responded to latest developments in (measurement) advances in the substantial sciences. At the end of the 90s, new genomics technologies made it possible to obtain snapshots of the activity of 10,000s of genes simultaneously. This has led to a new impulse in areas such as experimental design, sparse inference and functional statistics.

5.3.4 Science, Business and Policy (M-variant)

For whom?

All Master's students following a science Master degree programme at the University of Groningen can include a 60-ECTS programme in their own Master degree programme to prepare for a variety of jobs in the business world and in policy organizations. The programme includes business, policy and management. The emphasis is on integrating these modules into the students' own disciplines.

The specialization Science, Business and Policy is also called the M-variant. The 'M' stands for 'maatschappij' ('society') and indicates that the degree programme prepares students for jobs in society. The programme is offered faculty-wide by the Science & Society Group. Students generally follow the regular modules (e.g. mathematics) in the first year of their Master programme and modules of the M variant Science, Policy and Business in their second year.

Programme content

The M part of the programme consists of 60 ECTS. It consists of the Scientists in Policy & Business Module (20 ECTS) and a traineeship at a company or policy organization (40 ECTS). The programme aims at training students to be 'science advisors': broadly trained science academics who can build a bridge between scientific research, business strategy and policy within companies and policy organizations. At the end of the programme, students will be able

to independently draw up innovation advice or policies which are not only convincing in terms of content, but which are above all able to be implemented and are likely to gain support from within and outside the organization.

More information can be found at

<http://www.rug.nl/fwn/mvariant>

5.4 Programme requirements

5.4.1 Mathematics (P-variant)

The P-variant of the master programme mathematics has three specialization areas:

- Algebra and Geometry
- Dynamical Systems and Analysis
- Statistics and Probability

A student graduates on an individual programme, which has to be approved by the Board of Examiners. For more information on the approval of a master programme see Section 3.14.

The master programme comprises 120 ECTS. The requirements on the programme are the following

Student colloquium (5 ECTS)

At least five modules from the following list of local modules, the modules in your specialization area are compulsory (at least 25 ECTS)

Specialization area Algebra and Geometry:

- Algebra and Geometry (annual)
- Applied Geometry (annual)

Specialization area Dynamical Systems and Analysis:

- Dynamical Systems and Chaos (annual)
- Caput Dynamical Systems (biennial, 2010-2011)
- Caput Mathematical Physics (biennial, 2011-2012)

Specialization area Statistics and Probability:

- Statistical Genomics (biennial, 2011-2012)
- Contemporary Statistics with Applications (biennial, 2010-2011)

Specialization area Computational Science and Numerical Mathematics:

- Computational Fluid Dynamics (annual)
- Computational Engineering (biennial, 2010-2011)
- Boundary Layers (biennial, 2011-2012)

Specialization area Systems, Control and Optimization:

- Robust Control (annual)
- Introduction to Optimization (biennial, 2011-2012)
- Modeling and Identification (annual, 2010-2011)

At least three modules from the mastermath programme (at least 18 ECTS)

From these modules at least two have to be in your specialization area and at least one has to be outside your specialization area. See <http://www.mastermath.nl> for the mastermath programme and Section 7.2 for information about which mastermath modules offered in 2010-2011 belong to which specialization area.

At most 10 ECTS of advanced modules of programmes taught at the RuG other than the master programmes mathematics and applied mathematics

These modules have to be of at least third year bachelor level, and have to be relevant for the master Mathematics (at the discretion of the exam committee). See Section 7.3 for interesting modules.

Free choice (optional): at most 5 ECTS

Final Research Project: 50 ECTS

Research project in your specialization area.

5.4.2 Mathematics (M-variant)

The M-variant of the degree programme is called:

- Science, Business and Policy

A student graduates on an individual programme, which has to be approved by the Board of Examiners. For more information on the approval of a master programme see Section 3.14.

The master programme comprises 120 ECTS and consists of a mathematical component (60 ECTS) and a Business and Policy component (60 ECTS)

The requirements on the programme are the following.

Mathematical component (60 ECTS):

At least 15 ECTS from the following list of local modules. At least 10 ECTS have to be chosen from the modules of the specialization area.

Specialization Algebra and Geometry:

- Caput Algebra and Geometry (annual)
- Applied Geometry (annual)

Specialization Dynamical Systems and Analysis:

- Dynamical Systems and Chaos (annual)
- Caput Dynamical Systems (biennial, 2010-2011)
- Caput Mathematical Physics (biennial, 2011-2012)

Specialization Statistics and Probability:

- Statistical Genomics (biennial, 2011-2012)
- Contemporary Statistics with Applications (biennial, 2010-2011)

Specialization Computational Science and Numerical Mathematics:

- Computational Fluid Dynamics (annual)
- Computational Engineering (biennial, 2010-2011)
- Boundary Layers (biennial, 2011-2012)

Specialization Systems, Control and Optimization:

- Robust Control (annual)
- Introduction to Optimization (biennial, 2011-2012)
- Modeling and Identification (biennial, 2010-2011)

At most three modules from the mastermath programme (at most 18 ects)

See <http://www.mastermath.nl> for the mastermath programme and Section 7.2 for information about which mastermath modules offered in 2010-2011 belong to which specialization area.

At most 10 ECTS of advanced modules of programmes taught at the RuG other than the master programmes mathematics and applied mathematics

These modules have to be of at least third year bachelor level, and have to be relevant for the master Mathematics (at the discretion of the exam committee). See Section 7.3 for interesting modules.

Mathematical Research Project (30 ECTS)

Research project in the specialization area.

Business and Policy component (60 ECTS):

- Module Science, Business and Policy (20 ECTS)
- Internship Science, Business and Policy (40 ECTS)

6 Master Programme Applied Mathematics

6.1 Introduction

Why does one car have more air resistance than another? How can a satellite be kept in a stable orbit around the earth? Applied mathematicians provide the necessary theoretical background when trying to answer such questions, in close interaction with specialists from the field of application.

The Master programme in Applied Mathematics comprises two years of full time study, equivalent to 120 ECTS. To be admitted to the Master programme in Applied Mathematics, the student must have obtained the prerequisite Bachelor degree in Mathematics or Applied Mathematics.

Applied Mathematics is concerned with the development and exploitation of mathematical tools for the analysis and control of technological problems. Mathematical modelling of the problem at hand plays a basic role, followed by (numerical) analysis and (computer) simulation. Interaction with other disciplines is essential.

Our master programme Applied Mathematics has two specializations:

- Computational Science and Numerical Mathematics
- Systems, Control and Optimization

The specialization Systems, Control and Optimization deals with the mathematics behind designing stable controllers for satellites, purification plants, or more general technical processes. Questions that arise are: is it possible to suppress perturbations in a system? how can one stabilise and control a system without causing shocks?

In the specialization Computational Science and Numerical Mathematics the emphasis is on modelling, analysis and simulation of fluid flow problems. Although the applications can be quite diverse, the basic mathematical methods are much the same. If one is capable of computing the flow of air, one is able to predict the weather, and to design cars and aeroplanes. And those who can simulate the flow of water, can build ships, harbours and dikes.

The master programme Applied Mathematics consists not only of courses offered locally in Groningen (see Section 7.1), but also of courses offered by Mastermath (the cooperation of the mathematics departments of the Dutch universities, see Section 7.2).

A student graduates on an individual programme, which has to be approved by the Board of Examiners. This programme has to meet the requirements of the programme of one of the specializations of the master Applied Mathematics as described in this chapter. To avoid delay it is advised to ask the approval of the Board of Examiners immediately after starting the master programme. For help on composing the programme the student can turn to the student counsellor. For more information about the approval of a master programme see Section 3.14.

6.2 Objective

The objective of the Applied Mathematics master programme is to teach a student the knowledge, the skills, and attitude needed to pursue a professional (research) career in Applied Mathematics.

The student will gain specialized knowledge in the specializations Computational Science and Numerical Mathematics or Systems, Control and Optimization.

The master programme Applied Mathematics is concerned with the development and exploitation of mathematical tools for analysis and control of technological problems. Mathematical modelling of the problem at hand plays a basic role, followed by (numerical) analysis and (computer) simulation. Interaction with other disciplines is essential. One can combine applied mathematics with, for instance, mathematics, physics or computer science.

The student will learn how to solve a problem by using abstraction and modeling, to look for scientific literature on the subject, and to determine whether the problem can be solved by using existing methods or new techniques should be developed. The student will learn how to make mathematical models for and simulations of real-life problems from an industrial or academic research department. The student will learn to work in a multidisciplinary environment on real-life problems.

Finally, the student will learn how to present mathematical results in a written and oral form, both for a specialized and general audience.

6.3 Specializations

6.3.1 Computational Science and Numerical Mathematics

Over the last few decades, computation has joined theory and experiment as a third pillar of science, thanks to advances in numerical algorithms and computer hardware. Mathematical modeling and computer simulation are becoming commonly used tools for analysis and design of many ingredients of the world around us. Think of the daily weather forecast and the long-year climate predictions, the design of cars, airplanes and wind turbines, the construction of sea dykes, but also the study of blood flow and the design of heart valves. All rely heavily on accurate analysis and prediction by means of mathematical simulation.

The specialization Computational Science and Numerical Mathematics wants to prepare the students for this expanding interplay between modeling and computation. Knowledge from various disciplines is brought together. The translation from application towards mathematics ("Which model suits my purpose?") and back ("What do the mathematical results mean?") plays an important role. Thus, the curriculum consists of a mixture of (applied) mathematics, physics and computing science. Sufficient freedom is available to put an accent on the study programme, e.g. more on the (applied) modeling side or more on the side of (mathematical) method development.

For more information we refer to the web site <http://www.math.rug.nl/~veldman/>.

People

Dr. B. Carpentieri: Numerical linear algebra problems of continuous mathematics: solving large linear systems of equations and computing eigenvalues of large matrices. Theoretical aspects like conditioning, convergence properties of iterative methods, complexity analysis. Development of novel algorithms alongside the conversion to parallel computing. Biomedical applications.

Prof.dr. A.E.P. Veldman: Computational fluid dynamics (CFD) - design of simulation methods for flow problems: mathematical models as well as numerical algorithms. Applications include aerodynamics (aircraft, wind turbines), free-surface flow (water waves, liquid sloshing) and biomedical fluid dynamics (arterial flow, vocal folds).

Dr.ir. R.W.C.P. Verstappen: Mathematics of fluids, particularly mathematical modeling and numerical simulation of turbulence based on first principles; finding simplicity in the complexity of turbulence.

Dr.ir. F.W. Wubs: Development of numerical methods for bifurcation analysis of large scale systems, especially stable discretizations, and methods for the solution of sparse linear and non-linear systems and of sparse eigenvalue problems. Such methods must be fast on modern computers, hence allow for parallelization. Application area is CFD in general, with a special focus on incompressible Navier-Stokes equations and the thermohaline ocean model equation.

6.3.2 Systems, Control and Optimization

Systems and Control is the subfield of applied mathematics that deals with theory and applications of mathematical models, in particular with the analysis and design of dynamical systems in interaction with their environment, and with control and estimation problems for such systems.

Mathematical models that appear in Systems and Control often consist of underdetermined systems of differential equations in which certain variables can be given arbitrary values. These free variables are called inputs. Other variables in these models can represent the deviation from certain desired values, and therefore need to be kept small. Such variables are called regulation outputs. A typical example of control is to choose the inputs in such a way that the regulation outputs satisfy the desired properties. Often the inputs are chosen on the basis of measured outputs. This is called feedback control.

Examples of control problems are: controlling the movement of a robot arm in a production process, keeping a communications satellite in its desired orbit on the basis of measurements of its position, or keeping at a constant value the concentration of a chemical substance in a distillation column.

Optimization is the part of mathematics that deals with characterizing and computing the "best" point out of a finite or possibly infinite set of possible candidates. This is a highly versatile field with not only numerous potential applications but also a beautiful mathematical theory.

Optimization problems appear in many practical applications, for example railway scheduling, telecommunication networks, personnel staffing, finance, all kinds of manufacturing processes, but also in engineering or molecular biology. In some type of optimization problems, discrete decisions are involved (e.g. should a new bus route be opened - yes or no?).

People

Dr. K. Camibel: Control theory for nonsmooth dynamical systems, in particular piecewise affine dynamical systems. Fundamental problems of stability, controllability, stabilizability, and feedback stabilizability of piecewise affine systems. Mathematical tools that are used are geometric linear control theory, convex analysis, and theory of differential inclusions.

Dr. M. Dür: Optimization problems involving both discrete variables and nonlinear functions. Theoretical aspects like optimality conditions and duality theory as well as algorithmic methods to actually compute these optimal points. Semidefinite programming, i.e., problems involving matrix variables.

Prof. dr. A.J. van der Schaft: The mathematical study of complex interconnected dynamical systems as occurring in science and engineering (multi-physics engineering systems, systems biology, embedded systems, multi-agent systems, etc.). Geometric modeling of multi-physics systems as port-Hamiltonian systems, and modeling of hybrid systems. Analysis of properties of complex systems from the properties of their subsystems and applications (energy management systems, metabolic reaction networks in systems biology, etc.). Control as interconnection of systems.

Prof. dr. H.L. Trentelman: The behavioral approach to systems and control: mathematical models in terms of solution spaces of systems of underdetermined systems of differential equations. The study of approximation of mathematical models by reduced order models. Control by behavioral interconnections. Algebraic theory of linear partial differential equations.

6.4 Programme requirements

The master programme applied mathematics has two specialization areas:

- Computational Science and Numerical Mathematics
- Systems, Control and Optimization

A student graduates on an individual programme, which has to be approved by the Board of Examiners. For more information on the approval of a master programme see Section 3.14.

The master programme comprises 120 ECTS. The requirements on the programme are the following.

Student colloquium (5 ECTS)

At least five modules from the following list of local modules, the modules in your specialization are compulsory (at least 25 ECTS)

Specialization area Algebra and Geometry:

- Algebra and Geometry (annual)
- Applied Geometry (annual)

Specialization area Dynamical Systems and Analysis:

- Dynamical Systems and Chaos (annual)
- Caput Dynamical Systems (biennial, 2010-2011)
- Caput Mathematical Physics (biennial, 2011-2012)

Specialization area Statistics and Probability:

- Statistical Genomics (biennial, 2011-2012)
- Contemporary Statistics with Applications (biennial, 2010-2011)

Specialization area Computational Science and Numerical Mathematics:

- Computational Fluid Dynamics (annual)
- Computational Engineering (biennial, 2010-2011)
- Boundary Layers (biennial, 2011-2012)

Specialization area Systems, Control and Optimization:

- Robust Control (annual)
- Introduction to Optimization (biennial, 2011-2012)
- Modeling and Identification (annual, 2010-2011)

At least three modules from the mastermath programme (at least 18 ECTS)

From these modules at least two have to be in your specialization area and at least one has to be outside your specialization area. See <http://www.mastermath.nl> for the mastermath programme and Section 7.2 for information about which mastermath modules offered in 2010-2011 belong to which specialization area.

At least 10 ECTS of advanced modules from programmes of the RuG other than the master programmes mathematics and applied mathematics, like physics, applied physics, industrial engineering and management, chemistry, chemical engineering, astronomy, computing science and econometrics

These modules have to be of at least third year bachelor level, and have to be relevant for the master applied mathematics (at the discretion of the exam committee). See Section 7.3 for interesting modules.

Free choice (optional): at most 5 ECTS

Final Research Project: 50 ECTS

Research project in your specialization area. An internship of at least 15 ECTS is part of this project.

7 Modules

The master programmes of both Mathematics and Applied Mathematics not only consist of (applied) mathematics modules offered locally in Groningen but of (applied) mathematics modules offered by Mastermath as well. The modules of Mastermath are offered in centrally situated cities in the Netherlands. Furthermore, advanced modules from programmes of the University of Groningen other than the master programmes mathematics and applied mathematics can be a part of the programme as well.

7.1 (Applied) Mathematics modules in Groningen

The master programmes of both Mathematics and Applied Mathematics consist of at least five (applied) mathematics master modules offered in Groningen, the modules in your specialization area are compulsory. Part of these modules is offered annually, part biennially. Below the complete list of these modules is given. For course descriptions see OCASYS: <http://www.rug.nl/ocasys>.

Specialization area Algebra and Geometry:

- Algebra and Geometry (annual)
- Applied Geometry (annual)

Specialization area Dynamical Systems and Analysis:

- Dynamical Systems and Chaos (annual)
- Caput Dynamical Systems (biennial, 2010-2011)
- Caput Mathematical Physics (biennial, 2011-2012)

Specialization area Statistics and Probability:

- Statistical Genomics (biennial, 2011-2012)
- Contemporary Statistics with Applications (biennial, 2010-2011)

Specialization area Computational Science and Numerical Mathematics:

- Computational Fluid Dynamics (annual)
- Computational Engineering (biennial, 2010-2011)
- Boundary Layers (biennial, 2011-2012)

Specialization area Systems, Control and Optimization:

- Robust Control (annual)
- Introduction to Optimization (biennial, 2011-2012)
- Modeling and Identification (annual, 2010-2011)

7.2 (Applied) Mathematics modules of Mastermath

The master programmes of both Mathematics and Applied Mathematics consist of at least (and for the M-variant at most) three modules from the mastermath programme. From these modules at least two have to be in your specialization area and at least one has to be outside your specialization area.

What

The Departments of Mathematics of the Dutch universities have combined their efforts to enhance their Master programs in Mathematics. Part of the cooperation is aimed at organizing joint courses in mathematics. The joint courses offer the students the highest quality of instruction and open opportunities for interaction with students of other institutes of mathematics. For students who intend to pursue a PhD program after completing their Master programs the joint program widens the range of options open to them. See

<http://www.mastermath.nl>

Where

The courses of mastermath take place in centrally situated cities of the country (for instance Utrecht or Amsterdam). To prevent unnecessary travelling the courses in a particular

specialization area in Mathematics will be held on the same day of the week; the classes of one course will be held in the morning while those of another course will be held in the afternoon.

Mastermath programme 2010-2011

For each mastermath module offered in 2010-2011 the following tables mention to which specialization area it belongs. Note that since the mastermath programme is very broad, not all modules belong to one of the specialization areas. This does not mean that you are not allowed to take such modules. When a module is of special interest to a specialization area this is denoted in the third column of the tables. For most specialization areas it is not possible to say in advance which modules might be of interest. This depends on your general interest and choice of subject for the final research project. If you want more information about these modules contact your student councillor (see Section 3.6) or one of the scientific staff members working in the field of your specialization area (see Sections 5.3 and 6.3)

1st semester 2010-2011		
Module	Specialization area	Of special interest for Specialization area
Algebraic Number Theory	Algebra and Geometry	
Algebraic Topology	Algebra and Geometry	Dynamical Systems and Analysis
Asymptotic Statistics	Statistics and Probability	
Conservative Dynamical Systems	Dynamical Systems and Analysis	Systems, Control and Optimization Computational Science and Numerical Mathematics
Continuous Optimization	Systems, Control and Optimization	Computational Science and Numerical Mathematics
Didaktiek		
Discrete Optimization	Systems, Control and Optimization	
Functional Analysis	Dynamical Systems and Analysis	
Heuristic Methods in Operations Research	Systems, Control and Optimization	
Introduction to numerical bifurcation analysis of ODE's and maps	Dynamical Systems and Analysis	Computational Science and Numerical Mathematics
Introduction to Stochastic Processes	Statistics and Probability	Systems, Control and Optimization
Measure Theoretic Probability	Statistics and Probability	
Number Theory and Cryptography	Algebra and Geometry	
Numerical Linear Algebra	Computational Science and Numerical Mathematics	Systems, Control and Optimization
Parallel Algorithms		Systems, Control and Optimization Computational Science and Numerical Mathematics
Representation Theory	Algebra and Geometry	
Symplectic Geometry	Algebra and Geometry	Dynamical Systems and Analysis Systems, Control and Optimization
Systems and Control	Systems, Control and Optimization	Computational Science and Numerical Mathematics

2nd semester 2010-2011		
Module	Specialization area	Of special interest for Specialization area
Advanced Linear Programming	Systems, Control and Optimization	
Advanced Modelling in Science	Computational Science and Numerical Mathematics	Systems, Control and Optimization
Algebraic Geometry	Algebra and Geometry	
Applied Finite Elements	Computational Science and Numerical Mathematics	
Applied Statistics	Statistics and Probability	
Asymptotic Methods for Differential Equations	Dynamical Systems and Analysis	Computational Science and Numerical Mathematics
Complexity Theory		Systems, Control and Optimization
Diophantine Equations	Algebra and Geometry	
Empirical Processes and Statistical Learning	Statistics and Probability	
Geometry	Algebra and Geometry	
Historical Aspects of Classroom Mathematics		
Nonlinear System Theory	Systems, Control and Optimization	Dynamical Systems and Analysis Computational Science and Numerical Mathematics
Numerical Methods for Time-dependent PDE's	Computational Science and Numerical Mathematics	
Partial Differential Equations	Dynamical Systems and Analysis	Computational Science and Numerical Mathematics
Proof Theory		
Queuing Theory	Statistics and Probability	Systems, Control and Optimization
Scheduling	Systems, Control and Optimization	
Semisimple Lie Algebras	Algebra and Geometry	
Set Theory		
Stochastic Differential Equations	Statistics and Probability	Dynamical Systems and Analysis Systems, Control and Optimization Computational Science and Numerical Mathematics
Stochastic Processes	Statistics and Probability	

Course information

Information, including schedules and course descriptions, concerning Mastermath is available at the following website:

<http://www.mastermath.nl>

Mastermath divides the year into two semesters. Each semester both regular and intensive courses are offered. During each semester, classes of regular courses meet weekly for a period of 14 weeks. Around the sixth or seventh week of the term there is a break of one week, because the intensive courses meet for a full week during that week. The last six weeks of the term are reserved for study, homework, special projects and examination. The main activity of the intensive course is the one-week conference in the seventh week of the term. Before and after the conference several one-day meetings are scheduled. There are one-day meetings in week 1 and 3 for instructions, assigning subjects and handing out homework problems. In

week 10 are one or two meetings for the presentations by the students of their results. The workload of most regular courses will be 8 ECTS and of intensive courses 6 ECTS.

Supervision in Groningen

Students who are participating in a course of the Dutch Master Program can always ask the members of the mathematics department in Groningen for assistance.

Registration

The lectures of Mastermath are open to all students who are registered in a master programme in Mathematics at one of the Dutch universities. There is no additional registration fee. Students *must* register for a course at the registration page of the website of Mastermath,

<http://www.mastermath.nl/registration>

Timely notification of results and grades is only guaranteed if the student is registered.

Exams and grades

The student must take the exam in the period immediately following the class meetings. The grades are filed with the central administration of Mastermath which notifies the administration of the student's university of the grade. For this reason students have to register for the courses at <http://www.mastermath.nl>.

Travel cost

Only students who have a 'weekend OV-studentenjaarkaart' or NS reduction card ('Voordeelurenkaart') and students without any reduction card can claim their travel expenses. Travel expenses can be claimed at Mastermath, <http://www.mastermath.nl>.

7.3 Modules of other programmes

The programme of Applied Mathematics consists of at least and the programme of Mathematics of at most 10 ECTS of advanced modules from programmes of the University of Groningen other than the master programmes mathematics and applied mathematics. The choice of modules is at the discretion of the exam committee. In this section for each specialization area a number of interesting modules is given.

Modules of *general interest*

- Modules of the master Energy and Environmental Sciences
see <http://www.rug.nl/ocasys/fwn/vak/showpos?opleiding=3576>
- Modules of the master Educatie en Communicatie in de Wiskunde en Natuurwetenschappen
see <http://www.rug.nl/ocasys/fwn/vak/showpos?opleiding=3505>

For the *specialization Algebra and Geometry* modules of interest are

- Kosmologie (5 ECTS, BSc Astronomy, STCOSMOE5)
- General Relativity (5 ECTS, MSc Physics, NAGR-08)
- Large Scale Structure of the universe (5 ECTS, MSc Astronomy, STLSSSE5)

For the *specialization Dynamical Systems and Analysis* a module of interest is

- Statistical Mechanics (5 ECTS, MSc Physics, NASM-07)

For the *specialization Statistics and Probability* modules of interest are

- Applied Statistics (GMMSG08, I b and II a, GMW MSc, 5 ECTS)
- Applied Statistics for Econometrics (EBM805A10, I ab, FEB MSc, 10 ECTS)
- DNA Microarray Analysis (MLBB017, II a, FWN MSc, 5 ECTS)
- Experimental Design and Analysis of Variance (code GMMSG07, I a, GMW MSc, 5 ECTS)
- Factor Analysis (GMMSG04, I b, GMW MSc, 5 ECTS)
- Generalized Linear Models (EBB883A05, II a, FEB BSc, 5 ECTS)

- Machinaal Leren (LIX004M05, I a, LET MSc, 5 ECTS)
- Meth. and Statistics Ling. Research (LTR002M10, II ab, LET MSc, 10 ECTS)
- Multilevel Analysis (GMMSGE02, II a, GMW MSc, 5 ECTS)
- Multivariate Data Analysis (EBM895A10, I ab, FEB MSc, 10 ECTS)
- Statistics and Causality (FI094JR, Wijsbegeerte, periode Ib, ECTS 5)
- Statistical Mechanics (NASM-07, II a, FWN MSc, 5 ECTS)
- Statistical Methods in Physics (NASMPH05E, II a, FWN MSc, 5 ECTS)
- Stochastic Models (EBB878A06, I a, FEB BSc, 6 ECTS)

For the *specialization Computational Science and Numerical Mathematics* modules of interest are

- Computational Physics (5 ECTS, MSc Physics, NACOMP-07)
- Dynamica van Sterrenstelsels (5 ECTS, BSc/MSc Astronomy, STGALDYN6E)
- Introduction to Computational Science (5 ECTS, MSc Computing Science, INMICS-08)
- Fysische Transportverschijnselen 2 (5 ECTS, BSc Chemical Engineering, CHTFTV205E)
- Scientific Visualization (5 ECTS, MSc Computing Science, INMSV-08)
- Solid Mechanics (5 ECTS, BSc Applied Physics, NASM-08)
- Strategic Management of Technology (5 ECTS, MSc Industrial Engineering and Management, EBM764A05)

For the *specialization Systems, Control and Optimization* modules of interest are

- Mechatronics (5 ECTS, MSc Industrial Engineering and Management, NAMO05E)
- Neural Networks (5 ECTS, MSc Computing Science, INMNN-08)
- Robotics (5 ECTS, MSc Industrial Engineering and Management, NABP05E)

Course descriptions can be found in Ocasys (<http://www.rug.nl/ocasys>).

8 Educational Masters

8.1 Master Educatie en Communicatie

This master programme is taught in dutch only. Therefore, this section is in dutch as well.

Na je bachelor in één van de opleidingen van de Faculteit der Wiskunde en Natuurwetenschappen, kun je doorstromen naar de Masteropleiding Educatie en Communicatie in de Wiskunde en Natuurwetenschappen (EC-master). Met deze masteropleiding kun je in twee jaar een eerstegraads onderwijsbevoegdheid behalen of afstuderen in de wetenschapscommunicatie. Je kunt je met de EC-master specialiseren in bèta-educatie of bètacomunicatie. In deze specialisaties leer je educatieve en communicatieve producten te ontwikkelen voor het onderwijs, populair-wetenschappelijke tijdschriften, bedrijven en de overheid (bijvoorbeeld websites, cd-rom's en artikelen). Het is van belang dat je een behoorlijke dosis kennis van je vakgebied hebt. Daarom doet elke student een half jaar onderzoek in de eigen bètadiscipline. Het opleidingsprogramma is sterk gericht op integratie van de kennis uit de bètadisciplines met theoretische inzichten die betrekking hebben op onderwijs en communicatie en met praktische opdrachten. De keuze voor een specifieke richting hoef je nog niet te maken bij aanvang van de opleiding.

Voor meer informatie zie

<http://www.rug.nl/ec>

of neem contact op met de studieadviseur van de EC-master: ecstudieadviseur@rug.nl

8.2 Eén-jarige Master-na-Master Leraar Voorbereidend Hoger Onderwijs

This master programme is taught in dutch only. Therefore, this section is in dutch as well.

Naast de specialisatie Educatie van de EC-Master, is er nog een andere manier om een eerstegraads bevoegdheid te halen. Voor de vier schoolvakken, biologie, natuurkunde, scheikunde en wiskunde is er een éénjarige Master-na-Masteropleiding Leraar Voorbereidend Hoger Onderwijs (LHVO) die je kunt volgen na het behalen van een vak-master, dus een master in één van de genoemde vakken.

Deze éénjarige master-na-master kent twee fasen: een voorbereidend deel van de zomervakantie tot de herfstvakantie, en een onbetaalde LIO-stage vanaf de herfstvakantie. Wil je in aanmerking komen voor een betaalde LIO-stage, dan zul je voordat je aan de éénjarige post-master begint de Basiscursus Lerarenopleiding (10 ECTS) met voldoende resultaat afgerond moeten hebben. Dit kan door dit vak tijdens je vak-master te volgen of, als je voorafgaand aan de éénjarige master-na-master niet voor een opleiding ingeschreven staat, via contractonderwijs.

Voor toelating tot deze éénjarige post-master moet je in het bezit zijn van een Master diploma in biologie, (technische) natuurkunde, (technische) scheikunde of (technische) wiskunde. Voor toelating wordt de vakinhoudelijk kennis van de student getoetst aan de normen zoals opgesteld door de Interdisciplinaire Commissie Lerarenopleidingen (ICL).

Voor meer informatie over de éénjarige post-master LHVO zie

<http://www.rug.nl/ec/onderwijs/postmaster>

of

<http://www.rug.nl/uocg/lerarenopleiding/lerarenopleidingalsmasternamaster>

9 Research Institutes and Schools

9.1 Johann Bernoulli Institute

The research programmes of the Faculty of Mathematics and Natural Sciences of the university of Groningen represent a broad range of scientific disciplines. Each research programme is part of one of the thirteen research institutes of the faculty. The (Applied) Mathematics research programmes are united in the Johann Bernoulli Institute

The Johann Bernoulli Institute for Mathematics and Computer Science comprises two sections: Mathematics and Computer Science. These sections are clusters of basic units (basiseenheden) formed around chairs and research programmes: six mathematics research programmes and six computer science research programmes.

The following mathematics research programmes are part of the Johann Bernoulli Institute

- Algebra
- Geometry
- Systems, Control and Applied Analysis
- Computational Mechanics and Numerical Analysis
- Dynamical Systems and Mathematical Physics
- Probability and Statistics

The set of programmes as a whole has as its main goal performing research at a high international level, leading to publications in international scientific journals and a steady stream of highly qualified researchers (at PhD level). The intended audience consists of the academic research community on one hand and social and professional practice (e.g. industry, hospitals and administration) on the other hand. The Institute aims to provide an attractive research environment for graduate students by maintaining a modern infrastructure and by appointing highly competent and active scientific staff members.

The constituting programmes participate in Dutch research schools and clusters (see the next sections) and most of the PhD students are enrolled in the educational programmes and take part in other activities offered by these schools. After obtaining a PhD degree, young researchers continue their professional career in various environments, such as academia, government, administration, and industry in the country and abroad.

9.2 Mathematical Research Institute (MRI)

Education

The Mathematical Research Institute (MRI) is a national research school. It is the combined research school for the (applied) mathematics departments of the universities of Groningen, Nijmegen, Twente and Utrecht. Every year the MRI organizes:

- The Master Class programme; the Master Class offers a one-year programme centered around a theme that is close to one of the research areas supported by the MRI.
- The Spring School programme, which offers a 4 to 8-week intensive course (in March, April or May) in an advanced topic.
- The regular mathematical courses for the masterprogramme and the AiO-curriculum offered by the participating departments.

These courses are of interest for master students and beginning PhD students. Students who are interested in following a master class should contact their supervisor of the master research project.

Research

The research programme of the Mathematical Research Institute focuses on the fundamental aspects of mathematics, as well as on interactions with its applications. The MRI is strongly represented in the following fields:

- Algebra and Geometry, including topology, theory of numbers and interfaces with logic and discrete mathematics.
- Analysis, comprised of pure analysis, applied analysis and numerical mathematics
- Stochastics/OR, comprising statistics, probability and operations research
- History and Education.

For more information you can contact Prof.dr. H.W. Broer, look at

<http://mri.math.uu.nl>

or contact

science.mri@uu.nl

9.3 Research School J.M. Burgerscentrum (JMBC)

The JMBC is the Dutch research school for fluid mechanics. About fifty professors with their groups participate in it. These groups are located at the Delft University of Technology, Eindhoven University of Technology, University of Twente, the University of Groningen, the Radboud University of Nijmegen, Wageningen university, University of Utrecht and Leiden University.

They are from a number of disciplines; such as Civil Engineering; Mechanical Engineering; Maritime Technology; (Applied) Physics; Aerospace Engineering; Applied Mathematics and Chemical Technology. With the combined knowledge, skills and facilities of these research groups the JMBC offers a very stimulating, multidisciplinary environment for advanced research in fluid mechanics and for the education of talented graduate and postgraduate students.

At present more than 250 PhD-students participate in the JMBC. The research activities of the research school cover not only the development of theoretical models and mathematical methods and associated numerical tools, but also a wide spectrum of experimental investigations. The main goals of the JMBC are: Organisation of advanced courses for PhD-students. Researchers from industries and technological institutes also attend these courses. Co-operation with industries and technological institutes. The aim is to promote the use of up-to-date knowledge on fluid mechanics for solving practical problems. Strengthen the contacts between Dutch fluid mechanics research groups at universities and the international fluid mechanics community.

Research

The research programme of the JMBC has been ordered in research themes and focal points. The reason for this ordering is to present a combination of projects which have coherence, either in terms of physical models or in terms of mathematical methods.

The main themes are:

- Complex dynamics of fluids
- Complex structures of fluids
- Mathematical and computational methods for fluid flow analysis

Education

The purpose of the PhD-programme of the JM Burgerscentrum is the development of PhD-students into independent researchers in the field of fluid mechanics. To reach this goal a thorough and fundamental knowledge of fluid-mechanics phenomena and their mathematical and numerical modelling is required, as well as the ability to further develop this knowledge and to apply it to solve scientific and technical problems. An important part of the PhD-programme consists of the execution of a scientific research project under the supervision of an expert of the JMBC. A smaller part, of the order of half a year, consists of the participation in courses. This part, the training programme, is described below.

For more information you can contact Prof.dr. A.E.P. Veldman or Henri van der Heiden (the JMBC PhD coordinator of the university of Groningen) or look at

<http://www.jmburgerscentrum.org>

9.4 Research School Dutch Institute of Systems and Control (DISC)

Research school DISC is an interuniversity research institute and graduate school that unites all university groups in the Netherlands that are active in systems and control theory and engineering. It offers a nationally organized graduate programme for PhD students in this field.

Education

In the national graduate school on systems and control, PhD students are offered a course program of weekly lectures that are given by top specialists in a central location in Utrecht. The courses cover a wide range of topics from mathematical systems theory to control engineering and intend to bring PhD students in short time to an internationally recognized research level. Although meant for PhD students master students are allowed to attend the courses as well.

Research

Disc unites all academic research in the Netherlands in the field of systems and control, ranging from mathematical systems theory research to technology-driven control engineering. Mechanical manipulation of hard-disk heads, developing energy-efficient greenhouses, designing cars that drive-by-wire, autonomously walking or flying robots, operational strategies in process industry ... in all these examples systems and control theory plays a crucial role.

For an overview and description of the courses see

<http://www.disc.tudelft.nl>

Further information can be obtained from Prof.dr. H.L. Trentelman or Prof.dr. A.J. van der Schaft.

9.5 NWO cluster DIAMANT

DIAMANT (Discrete, Interactive and Algorithmic Mathematics, Algebra and Number Theory) is one of the four 'mathematics clusters' in the Netherlands. The clusters are funded by NWO and the ministries of EZ and OCW. DIAMANT is based at four sites: the Centrum voor Wiskunde en Informatica (CWI) in Amsterdam, the Radboud Universiteit (RU) in Nijmegen, the Technische Universiteit Eindhoven (TUE), and the Universiteit Leiden (UL). In addition, there are a number of participants from the Universiteit Utrecht (UU) and the Rijksuniversiteit Groningen (RUG).

Twentieth-century mathematics focused primarily on the existence of mathematical objects. Will the trend towards constructing them lead to a change of emphasis in the new century? With the continuing explosion in computer technology, striking applications have been discovered for several of the traditionally purest parts of mathematics. Modern computer security depends crucially on number theory and algebra, and one cannot imagine operations research without discrete mathematics or program verification without logic. Dutch scholars, both in the Netherlands and abroad, have made remarkable contributions to all of these subjects.

The DIAMANT initiative is built around the algorithmic approach in algebra, discrete mathematics, logic, and number theory. The theme is interpreted broadly, with special attention given to subjects on the interface with neighboring disciplines. DIAMANT concentrates on high-level original research, drawing its techniques largely from fundamental mathematics. Research of this nature has yielded many applications in recent years and has the potential to create important new ones. The principal application area is networks, especially optimization and security. In addition to the fundamental study of algorithms and their correctness, the actual design and development of usable software systems form

part of the DIAMANT research effort.

In several fields covered by DIAMANT biweekly intercity seminars will be organized. Typically, a seminar lasts a full day, and it provides ample possibilities for interaction, both formal and informal. In addition, DIAMANT will organize semi-annual or annual cluster-wide research meetings of broader scope.

DIAMANT offers master courses at Mastermath. The mathematics of DIAMANT mostly falls in the sections algebra and geometry and operations research.

For further information you can contact Prof.dr. J.Top or look at

<http://websites.math.leidenuniv.nl/diamant>

9.6 NWO cluster Nonlinear Dynamics of Natural Systems (NDNS+)

NDNS+ (Nonlinear Dynamics of Natural Systems, the + stands for the stochastic aspects) is an NWO (Netherlands Organization for Scientific Research) cluster, focused on the interaction between the mathematical theory of dynamical systems and the complex models of life and earth sciences. Also there is some focus on related fundamental research. The University of Groningen is the center of the cluster, and main nodes of the cluster are at CWI , University of Leiden, TU Eindhoven and VU University Amsterdam.

Some of the central themes associated to the interaction between the mathematical theory of dynamical systems and the complex models of life and earth sciences include bifurcations and chaos, networks and delays, scientific computing (both numerical and geometrical), transient dynamics, multiple scales, patterns and waves. Moreover, probability models explicitly allow for indeterminism, and are highly suitable to model complicated processes in living cells, the behaviour of organisms and populations that are their aggregates, as well as in climate modeling. At present the application of such models in the life sciences and in meteorology is a wide-open area. Such models are applied in the NDNS+ cluster to statistical genetics, epidemiology, analysis of high-dimensional data, modelling of networks, cell processes and population dynamics, and image analysis as well as in the natural variations of the Northern Atlantic climate.

In the NDNS+ cluster young researchers are recruited for joint projects. Furthermore the NDNS+ organizes workshops.

For further information you can contact Prof.dr. H.W. Broer or look at

<http://www.ndns.nl>

9.7 Other Research Institutes and Clusters

Other research institutes and clusters of interest for mathematicians are the Euler Institute for Discrete Mathematics and its Applications (EIDMA)

<http://www.win.tue.nl/wsk/eidma>

the NWO cluster Geometry and Quantum Theory (GQT)

<http://www.gqt.nl>

and the NWO cluster Stochastics – Theoretical and Applied Research (STAR)

<http://www.eurandom.nl/CLUSTER>

10 Rules and Regulations

In this chapter you find legal information concerning the student and the Master's degree programmes.

10.1 Teaching and Examination Regulations (OER)

The Teaching and Examination Regulations (OER) of 2010-2011 will be published before 1 September 2010 at

<http://www.rug.nl/fwn/informatievoor/studenten/reglementen/oer-en>

10.2 Rules and Regulations of the Board of Examiners.

The Rules and Regulations of the Board of Examiners of 2010-2011 will be published before 1 September 2010 at

<http://www.rug.nl/fwn/informatievoor/studenten/reglementen/RenR>

10.3 Student Charter

The Student Charter provides an overview of the rights and obligations of both students and the University. It is based on national legislation, particularly the Higher Education and Research Act (WHW), supplemented by regulations that are specific to the University of Groningen. These latter regulations are set out in the appendices to the Student Charter.

The Act stipulates that the Student Charter comprises two sections: a university-wide section and a programme-specific section.

The **university-wide section** describes the rights and obligations that apply to the university as a whole, such as registration and protection of rights. You can find this section on the internet (www.rug.nl/studenten/ > Legal position > Students' Charter).

The university-wide section of the Student Charter does not literally quote the articles from acts and regulations but describes them as clearly as possible. The various topics are accompanied by links to the relevant articles of the act or regulation in question.

The **programme-specific sections** describe the rights and obligations that apply to specific degree programmes. These sections include the Teaching and Examination Regulations (OER), Rules and Regulations for examinations and final assessment and other regulations and provisions set by the various degree programmes and faculties. You can consult your programme-specific section at the faculty Education Offices and in the Study Guides.

Applicability

The Student Charter applies to academic year 2010-2011. The university-wide section of the Student Charter is approved annually by the Board of the University and endorsed by the University Council. In the event that the Charter challenges or contradicts any legal regulations, these legal regulations will take priority.

Publication

At the start of the academic year all students will be sent an e-mail by the Board of the University informing them where they can find the Student Charter on the internet and where they can consult a hardcopy of the Student Charter.

Using the Student Charter

All students are expected to be familiar with the contents of the Student Charter. Not complying with the rules in the Charter may affect your rights, for example the right to financial support from the Graduation Fund.

Some of these regulations may not be as hard and fast as they sound. Rules and regulations are by definition general in character, and this Student Charter is no exception. This means that the applicability of these regulations in concrete situations and individual instances is not always a predictable and straightforward matter. Students who have registered for the first time this year may find that the regulations that apply to them are different to those for students who have reregistered. Make sure you are provided with the right information by your faculty and/or the Student Service Centre (SSC) and read the Student Charter and the associated regulations carefully!

Items in the Student Charter

The university-wide section of the Student Charter contains information on the rights and obligations of students regarding the following items:

- admission,
- registration and deregistration,
- teaching, including the binding study advice,
- examinations and final assessments,
- financial assistance,
- consultative participation,
- rules of behaviour,
- legal rights.

11 Staff

11.1 Contact data

Visiting Address Department of Mathematics

Bernoulliborg, Nijenborgh 9, 9747 AG Groningen

Student administration, 'Bureau Onderwijs en Examens'

email: boenb4@rug.nl

tel: 050-363 4422

room NCC 5111.0077

Mrs. J.E.G. van Leeuwen, Mrs. F.F. de Haan-Durenkamp

Undergraduate Coordinators

vacancy

Mrs. P.J. Kruizinga-Huisman (assistent), room 5114.0016, tel. 050 – 363 4823,

e-mail: P.J.Kruizinga-Huisman@rug.nl

Student Counsellor

vacancy

International Coordinator

vacancy

IT Servicedesk

e-mail : servicedesk.zernike@rug.nl

NCC, Nijenborgh 4, room 5116.0308, tel. 050-363 4341

Bernoulliborg, Nijenborgh 9, room 5161.0257, tel. 050-363 8100

Algebra research group

Prof.dr. J. Top, room Bernoulliborg 396, tel. 050 – 363 3986, e-mail: J.Top@rug.nl

Dynamical Systems and Mathematical Physics research group

Prof.dr. H.W. Broer, room Bernoulliborg 472, tel. 050 – 363 3959, e-mail: H.W.Broer@rug.nl

Other faculty: Dr. A.C.D. van Enter, Prof.dr.ir. H.S.V. de Snoo, Prof.dr. H. Waalkens,

Dr. K. Efstathiou, Prof.dr. E. Verbitskiy

Geometry research group

Prof.dr. G. Vegter, room Bernoulliborg 470, tel. 050-363 3930, e-mail G.Vegter@rug.nl

Probability and Statistics research group

Prof.dr. E. Wit, room Bernoulliborg 446, e-mail E.Wit@rug.nl

Systems, Control and Applied Analysis research group

Prof.dr. A.J. van der Schaft, Bernoulliborg 380, tel. 050-3633731, e-mail

A.J.van.der.Schaft@rug.nl

Other faculty: Prof.dr. H.L. Trentelman, Dr. M.K. Camlibel, Dr. M.E. Dür

Computational Mechanics and Numerical Mathematics research group

Prof.dr. A.E.P. Veldman, room Bernoulliborg 450, tel. 050-3988, e-mail A.E.P.Veldman@rug.nl

Other faculty: Dr. B. Carpentieri, Dr.ir. R.W.C.P. Verstappen, Dr.ir. F.W. Wubs, Dr. R. Luppens

11.2 List of faculty members and supporting staff

	Extensionnr 050 363 ...	E-mail (..@rug.nl)	Room Bernoulli- borg
Department Chair: Prof.dr. G. Vegter	3930	G.Vegter	470
Coordinators vacancy	-	-	-
Mrs. P.J. Kruizinga-Huisman (assistent)	3977	P.J.Kruizinga-Huisman	5114-0016 Nijenborgh 4
Student Counsellor vacancy	-	-	-
Bureau Educations and Exams Mrs. J.E.G. van Leeuwen Mrs. F.F. de Haan-Durenkamp	4422	boenb4	5111.0077 Nijenborgh 4
Faculty members			
Prof.dr. H.W.Broer	3959	H.W.Broer	472
Dr. M.K. Camlibel	4144	M.K.Camlibel	382
Dr. B. Carpentieri	8991	B.Carpentieri	453
Dr. M.E. Dür	3996	M.E.Dur	386
Dr. K. Efstathiou	7061	K.Efstathiou	464
Prof.dr. A.C.D. van Enter	4967	A.C.D.van.Enter	484
Dr.ir. R. Luppés	3938	R.Luppés	449
Prof.dr. A.J. van der Schaft	3731	A.J.van.der.Schaft	380
Prof.dr.ir. H.S.V. de Snoo	3963	H.S.V.de.Snoo	478
Prof.dr. J. Top	3986	J.Top	396
Prof.dr. H.L. Trentelman	3998	H.L.Trentelman	392
Prof.dr. G. Vegter	3930	G.Vegter	470
Prof.dr. A.E.P. Veldman	3988	A.E.P.Veldman	450
Prof.dr. E.A. Verbitskiy	3780	E.A.Verbitskiy	443
Dr.ir. R.W.C.P. Verstappen	3958	R.W.C.P.Verstappen	455
Prof.dr. H. Waalkens	4870	H.Waalkens	476
Prof.dr. E.C. Wit	5170	E.C.Wit	446
Dr.ir. F.W. Wubs	3994	F.W.Wubs	451