Study Regulations for the Master's Program in Scientific Computing at Technische Universität Berlin

(read-only version: The version at hand is a non-official text in which changes and corrections are partially incorporated. Decisive and legally binding is the version in the Amtliches Mitteilungsblatt der Technischen Universität Berlin AMBl. TU 23/2006, released August 31st 2006.)

On 14 July 2005, the Board of Faculty II - Mathematics and Natural Sciences enacted the following study regulations for the master's program in Scientific Computing in accordance with Section 71 (1) no. 1 of the Berlin State Higher Education Act (*Berliner Hochschulgesetz* - BerlHG) in the version of 13 February 2003 (Berlin Gazette of Laws and Ordinances [GVBl.], page 82), last amended by the Act of 21 April 2005 (GVBl. page 254).

Overview of contents

I. General regulations

Section 1 Scope of application

These study regulations govern the objectives, content and structure of the Scientific Computing master's program on the basis of the examination regulations. The Institute of Mathematics works together with other institutes at Technische Universität Berlin to offer the degree program. Technische Universität Berlin also works together with the Zuse Institute Berlin (ZIB) and the Department of Mathematics as well as other departments at Freie Universität Berlin.

Section 2 Admission requirements

The admission requirements for the master's program are set down in a separate set of admission regulations.

Section 3 Standard period of study, program start date

(1) The standard period of study, including completion of the master's thesis, is four semesters.

(2) Students may begin the program either in the winter semester or in the summer semester.

Section 4 Learning outcomes and professional fields

One of the most striking features in the development of almost all fields of knowledge is the ever-increasing use of mathematical methods and ways of thinking. Mathematics has long been used in the natural and engineering sciences; more recently, mathematical methods and procedures have also come to play an increasingly important role in fields such as economics and the social sciences, medicine, biology, psychology, and linguistics. This goes hand in hand with the growing efficiency of data processing, which enables the solution of increasingly complex problems. Modeling, simulation and numerically-based calculations assume a central position in this discipline.

Just as diverse as the fields of application are the potential areas of deployment for mathematicians in industry, business and administration, research institutes, institutions of higher education and universities of applied sciences. Important fields of professional activity can be found in the worlds of mechanical engineering (focusing for instance on the strength of materials or vibration problems) and electrical engineering (for instance, control engineering, field calculations, network planning and communication technology), in the chemical industry (for instance, reactor calculations and statistical methods), in the aerospace industry (for instance, flow calculations or path determinations), in civil engineering (for instance, statics and the stability of materials), in biology and medicine (for instance, epidemic models or diagnostic evaluations), in business and economics (for instance operations research, organization and planning, the securities industry and consulting), in insurance, in research institutions of all kinds – and indeed in all of the aforementioned areas through the use of data processing, in which regard the computer industry itself represents a significant sphere of activity for mathematicians.

The aim of this degree program is to enable students to undertake academic and technical tasks and solve problems from the areas named above and similar areas of application. This will be achieved

through the use of mathematical modeling, analysis of mathematical models and the development of numerical procedures including the implementation of the procedure as software. Students acquire an in-depth specialist understanding of scientific computing, an overview of its application in the engineering and natural sciences and will have the skills to work independently in accordance with scientific methods.

Section 5 Overview of the degree program

The program is structured into the following areas, the requirements of which are specified in Section 8.

Area 1: Scientific Computing

Area 2: Applied Mathematics

Area 3: Application Discipline

Area 4: Electives

Area 5: Mathematical Seminars

Area 6: Research Internship

Area 7: Master's thesis

Section 6 Academic advising and degree schedule

(1) The Academic Advising Service at Technische Universität Berlin provides general help and assistance and psychological counseling.

(2) Students requiring course guidance can consult the course advisors at the Institute of Mathematics. The course advisors perform the following tasks:

- Organize an orientation event for new students at the start of every semester
- Publish a study guide
- Maintain contacts with other central academic advising and course guidance services

(3) Students commencing their studies are required to participate in an academic advising session (see Section 24 (1) letter d of the Examination Regulations (*Prüfungsordnung* – PO)). Students should select a professor or adjunct lecturer (*Privatdozenten*/*Privatdozentin*) from one of the mathematical subject areas to be studied, to be their mentor. Working together with their mentor, they develop a degree plan indicating which courses from areas 1-5 they plan to study, taking into account the courses taken in their bachelor's degree. This includes a schedule for completing their studies. The degree schedule can be adapted every semester in consultation with their mentor. Mentors act in an advisory capacity only.

Section 7 Teaching formats (class formats)

(1) The Scientific Computing degree program requires active participation in various types of classes. Teaching places a particular focus on independent work to solve mathematical problems, thereby highlighting and addressing gaps in a student's knowledge and skills base. In certain cases, students

may be required to work independently to acquire an understanding of aspects of non-mathematical disciplines.

(2) Lectures (VL)

Lectures involve a formal presentation on a defined academic issue with the aim of imparting basic or advanced knowledge of an aspect of mathematics or scientific computing.

(3) Practical tutorials (UE)

Students are required to work independently and intensively with the issues covered in the lectures so as to achieve an understanding of the topics covered. They have the opportunity to do so in practical tutorials usually organized in conjunction with specific lectures. Practical tutorials are usually subdivided into “homework”, “major exercises” and “tutorials”.

1. Homework

   Students are to complete tasks set by the teaching staff in their own time; these are usually to be submitted in written form.

2. Major exercise

   These tasks are performed under the supervision of a professor or another member of academic staff. All participants work together on the tasks to develop and present possible solutions. If required, additional aspects not covered in the lectures are also discussed.

3. Tutorial (TU)

   Working in small groups under the supervision of a professor, another member of academic staff or student tutors, participants work through any difficulties they have in understanding and working with the course content and discuss questions arising from their studies. Students are encouraged to participate actively in the process of discussing various approaches to a range of tasks.

(4) Integrated class (IV)

This teaching format combines aspects of lectures and exercises into a single session.

(5) Seminar (SE)

Seminars provide their participants the opportunity to develop and demonstrate their independent academic working skills and to formulate and present findings. Seminars are often provided in conjunction with lectures. Working with original literature (journals, research reports and sometimes books), they usually focus on a more restricted number of issues and topics than are covered in lectures. The text work usually requires a specialist understanding of the issues involved and the need to work independently to complete solutions to partially solved problems or to tackle problems in their entirety. Participants are required to work as independently as possible to develop an understanding of the issues involved. However, close guidance is available from academic staff. The mathematical seminars are intended to help participants determine the topic of their master’s thesis. Participants are usually required to give a presentation lasting a double class session. As such, class sizes should be limited to a maximum of 12 students. Students may have to demonstrate knowledge and understanding of specific issues to participate in seminars.

This type of class (usually two hours in duration) involves presentations followed by discussions. It is accompanied by multi-hour preparatory classes for one or more students which are arranged between the student(s) and the relevant member of staff. A number of seminars require participants

to submit their oral presentation in writing; this helps students learn to present complex mathematical issues in writing.

(6) Reading course (LK)

Working with the literature provided by the lecturer, students independently develop an understanding of the material taught in the class, which they then discuss with other course participants and the lecturer at regular intervals. A reading course can be supplemented by exercises.

(7) Working group, colloquium (AG, CO)

The Institute of Mathematics also runs classes called “working groups” and “colloquia”; their structure and organization is similar to that of a seminar.

These classes focus on current problems in mathematical research. In addition to introducing students to the latest research, they act as continuing professional education classes for graduate teaching staff and professorial staff (in the area of mathematics, such functions are not mutually exclusive).

(8) In addition to the forms of teaching outlined above, students will also be required to pursue independent study to complete their degree.

Section 8 Proof of credits earned

(1) Admission to the master’s examination requires that students submit proof of the credits earned (see Section 24 (3) PO), certifying the credit points awarded for the tutorials and internships.

(2) The procedure and conditions for awarding credits are to be announced at the start of a module. The criteria are established by the module instructor.

(3) The proof of credits earned should record the nature and format of the assessment.

(4) There is no limit to the number of times that classes can be repeated.

II. Special section

Section 9 Degree program requirements

(1) The following credits must be acquired in the following individual areas. Credit points (CP) are awarded on the basis of the European Credit Transfer System (ECTS).

Area 1: Scientific Computing (27 CP):

The module “Scientific Computing” must be completed in this area. Further modules with a total of 20 credit points are to be selected from the following list:

- Numerical Mathematics
- Numerical Mathematics for engineers II
- Differential Equations II
- Numerical Linear Algebra
- Differential Algebraic Equations

- Control Theory
- Numerics of Partial Differential Equations
- Finite Volumes for Solving Differential Equations
- Specialist classes from this area

The Examination Board is responsible for all decisions pertaining to the selection of alternative modules.

Area 2: Applied Mathematics (20 CP):

Modules amounting to 20 credit points must be taken in this area from the following list:

- Modeling with Differential Equations
- Variational Calculus and Optimal Control
- Mathematical Visualization I and II
- Graphs and Network Algorithms (ADM I)
- Probability Theory II
- Stochastic Models
- Non-Linear Optimization
- Financial Mathematics I and II
- Specialist classes from this area

The Examination Board is responsible for all decisions pertaining to the selection of alternative modules.

Area 3: Application Discipline (19 CP):

Students are to select specialist modules with a scope of 19 CP in this area from one of the permitted application disciplines: physics, chemistry, engineering, biology or medicine. Doubts as to the permissibility of a choice and the possibility of selecting modules from other disciplines are to be addressed to the Examination Board, which will rule on these matters.

Area 4: Electives (5 CP):

Students are to select modules worth 5 CP in this area from all the courses taught at Technische Universität Berlin.

Area 5: Mathematical Seminars (12 CP):

Two mathematical seminar modules worth 6 CP each are to be selected from the courses offered by the Institute of Mathematics.

Area 6: Research internship (7 CP):

Students must complete a research internship worth 7 CP. The modalities are specified in Section 10.

Area 7: Master's thesis (30 CP):

Students writing a master's thesis are required to work independently and use scientific methods to complete a task from the area of scientific computing (see Section 22 PO).

(2) Students are required to acquire certificates of performance demonstrating that they have earned the credits specified in the module descriptions.

(3) Courses that were the subject of the bachelor's degree program of the student concerned or that have a considerable overlap in content with courses from other modules may not be considered in Areas 1 to 5. In cases of doubt, the Examination Board shall decide.

(3) In the event that the range of courses offered does not allow a combination of modules with the required number of credit points in Areas 1 to 4, the Examination Board can permit a total of up to 2 credit points to be transferred between the areas. The number of credit points earned in the areas may change by a maximum of two points. Should this not prove to be possible, students may earn an additional 4 credit points in Areas 1 to 4, which are taken into account in the calculation of the overall grade in accordance with Section 12 (4) PO.

(4) Students require a total of 120 credit points to complete their studies.

(5) The dean of studies for mathematics publishes a list of further modules which students can select in Areas 1 to 3 from the courses taught at Technische Universität Berlin and other universities in the Berlin area (Freie Universität, Humboldt Universität and the University of Potsdam). A number of consecutive three-semester sequences for Areas 1 and 2 will be published on the homepage of the Institute of Mathematics. Students wishing to select classes not specified in the previous statements require permission from the Examination Board.

(6) Within the scope of area 5, students are expected to participate regularly in lectures and colloquia run by the institute.

(7) Classes will be taught in German or English.

Section 10 Research internship

(1) Students are required to complete a research internship with a minimum scope of six weeks (full-time) during the non-lecture period, usually in the third university semester. The internship serves to introduce students to certain research and development tasks and can be completed at an institute outside the University, as long as the requirement of academic supervision can be satisfied. Students must consult the internship coordinator to obtain their approval for their choice of research internship.

(2) Working on the basis of a certificate from the internship provider recording the schedule and content of the internship, and its successful completion, the internship coordinator shall decide whether to recognize the internship as an assessment worth 7 credit points (see Section 21 (5) PO).

Section 11 Module descriptions and annexes to the study regulations

The module descriptions are decided by the faculty board and published on the homepage of the Institute of Mathematics. The faculty board can change module descriptions to reflect changes in the situation as long as the number of credit points and aims of the degree program are not changed.

III. Final part

Section 12 Entry into force

These regulations take effect on the day after their publication in the Technische Universität Berlin Official Gazette.

Annex 1 to the Study Regulations

Sample Course Schedule

Sem.	1.	2.	3.	4.
Area 1	Module (7 CP) 2 Modules (10 +5 CP)	Module (5 CP)		
Area 2		Module (10 CP)	Module (10 CP)	
Area 3	Module (8 CP)		Module (11 CP)	
Area 4		Module (5 CP)		
Area 5		Module (6 CP)	Module (6 CP)	
Area 6		Non-lecture period: Research internship (7 CP)		
Area 7				Master's thesis (30) CP
Σ CP	30	30	30	30