Doctoral program

(1) Short Description of the PhD program in Mathematics and Computer Science

Independent research activity is the most important part of the PhD program. Each PhD student has a supervisor who is fully responsible for directing and helping the student's activities, including the selection of the subjects to be studied, the research work, the publication of the results and the preparation of the PhD thesis work. Two supervisors are permitted only in the case of interdisciplinary research or in the framework of an international cooperation – in these cases a prior permission is required, given by the Doctoral Council of the Doctoral School (DC) and approved by the Doctoral Council of the University (DCU). If the research activity is part of a cooperation agreement between the Doctoral School and a research institute of the Hungarian Academy of Sciences and therefore the supervisor is not a university staff member then the DC assigns an internal consultant as well.

During the PhD program the student must ***study*** various subjects. The courses are partly offered by the Doctoral School but MSc level courses offered by this university and PhD level courses offered by other universities can also be selected with the prior permission of the DC. Most of these „study" credits should be collected in the ***first phase*** (during the first four semesters) of the program. Further credits can be collected in the ***second phase*** (during the last four semesters) as well, mostly by participating at international „summer schools" or other intensive scientific activities.

The student must also participate in the ***teaching*** activity at the university in order to enhance his/her lecturing and communicating abilities. The subjects to be taught, the form of this activity (teaching assistant, grader etc) and the credits for these are determined by the head of the supervisor's department.

An essential part of the program is the regular ***consultation*** betwen the student and the supervisor, to help the research and publication activities of the student. The level and effectiveness of these consultations are graded by the supervisor. A necessary condition of receiving credits for this activity is to present the student's results at the PhD conference of the Doctoral School. Most of the „research" credits, however, should be obtained by ***publishing*** the student's results in international scientific research journals and presenting them at

international conferences, especially during the second phase of the program. Further credits can be granted for research performed at partner institutions in case of international research agreements.

The student is expected to obtain enough „publication" credits during the eight semesters of the program to meet the necessary minimal publicational requirements for the PhD degree.

(2) Recommended Schedule of the Credit Program for the Eight Semesters

Type of the credits	**total # credits**	**1st semester**	**2nd semester**	**3rd semester**	**4th semester**	**5th semester**	**6th semester**	**7th semester**	**8th semester**
		first phase of the program				second phase of the program			
Study	20 +10	10	5	5		5	5		
Teaching	16 + 8	4	4	4	4	4	4		
Research 1 (consultation)	64 +64	16	16	16	16	16	16	16	16
Research 2 (publishing)	20 +30		5	5	10	5	5	10	10
Research 3 (thesis writing)	0 + 8							4	4
Total	**120+120**	**30**	**30**	**30**	**30**	**30**	**30**	**30**	**30**

A total of 240 credits must be obtained during the four years of the program. The minimum and maximum values of the credits in each group are given in the following table:

Study	25-40 credits
Teaching	20-32 credits
Research 1 (consultation)	80-128 credits
Reseach 2 (publishing)	40-80 credits
Research 3 (thesis writing)	0-8 credits

Concerning „**Study**" credits – in justified cases - the supervisor may also announce a reading course for the doctoral student - for 3 credits per course. These „reading courses" need to be registered in the Neptun system, and other doctoral students are also eligible to take these courses. During the reading course, the supervisor assigns a topic that the doctoral student will learn from books, with the help of occasional consultations. The course ends with an exam. The

total number of credits obtained for reading courses - in the period before the complex exam - may not exceed 12.

Concerning "**Research 1**" (Consultation) subjects, the necessary condition for obtaining the minimum 80 credits is that the student has to participate in at least one scientific seminar - in at least 6 of the 8 semesters, in consultation with the supervisor (e.g. BME, ELTE, CEU, Rényi Institute, or any other high-quality seminar). Credits are given by the supervisor, it is the supervisor's responsibility to check the participation of the student in the seminar.

In the **teaching activity**, during the PhD program, the student can obtain a total of 4 credits (with the approval from the head of the department) for correcting midterm exams or homework assignments, for consultation, or for activities promoting the university. Additional teaching credits can only be obtained with the following teaching activities:

- 4 credits can be acquired for teaching 2 contact lessons per week
- 4 credits can be acquired for 2 hours study room supervision per week / assisting study group for 2 hours per week

It is the responsibility of the supervisor and the head of the department to ensure that the PhD student is assigned to a teaching task that he or she can perform at an appropriate level.

(3) Comprehensive Examination

The comprehensive exam may be taken at the end of the fourth semester, subject to the approval of the DC, if the student obtained all the study credits prescribed by the DC and at least 90 credits in total. If a student performed high level study and research activities in the past and wishes to attend Semesters 5 through 8 only then this exam serves as the entrance exam to the Doctoral School.

This is a public exam in front of a committee, consisting of at least three members where at least one third of the members is external (not employed by the university). The chair of the committee must be a regular or emeritus professor, or must possess the degree „Doctor of the Hungarian Academy of Sciences”. The student’s supervisor is a nonvoting member of the committee and must prepare a detailed evaluation of the performance of the student. This evaluation must be submitted in electronic form to the chair of the committee at least one week before the exam.

The exam consists of two parts. The „theory part” evaluates the knowledge of the student in two areas of mathematics. The list of the possible areas is given in Chapter (4) below and is also available at the home page of the Doctoral School. The „dissertation part” evaluates the state of the student’s research activity. In this part the student describes his knowledge in the relevant literature, his new scientific results obtained so far, his planned schedule for publication and thesis writing during the next four semesters. During his/her lecture the student must evaluate the significance of the research and, if applicable, the practical applicability of the results. The short summary of the results and the list of the (submitted, accepted or published) articles must be submitted in electronic form to the chair of the committee at least one week before the exam.

Each member of the exam committee separately evaluates both parts of the exam. The exam is successful if the majority of the committee members find both parts successful. Otherwise the unsuccessful part(-s) of the exam can be repeated at most once during the exam period of the actual semester. A written protocol must be prepared about the exam and should be announced

to the student in the same day. The grade of the complex exam does not influence the qualification level of the PhD title but the successful exam is a prerequisite of entering the second phase of the doctoral program.

(4) Subjects of the „Theory Part" of the Comprehensive Examination

The subjects of the exam must be selected from the list below. Two distinct ***groups*** should be selected at first, then the student may select any pair of ***topics*** within both groups. The final selection must be approved by the DC. The detailed content of each topics will be available in the homepage of the Doctoral School.

Name of the group	Topics within the group
Algebra and Logics	Group Theory, Group Representations, Semigroups and Automata, Ring Theory, Co Linear Algebra, Universal Algebra and Lattice Theory, Model Theory and Algebraic L in Computer Science.
Analyis	Measure and Integral, Operator Algebras, Matrix Analysis, Complex Analysis, Fourie Approximation Theory, Numerical Methods
Differential Equations	Ordinary Differential Equations, Partial Differential Equations, Numerical Methods
Discrete Mathematics and Computer Science	Combinatorial Analysis and Graph Theory, Matroid Theory, Combinatorial Optimiza Learning, Data Mining and Its Applications
Geometry	Spline Modelling of Surfaces, Algorithms of Computational Geometry, Lattice Geome Combinatorial Geometry, Differential Geometry, Riemannian Geometry
Number Theory	Combinatorial Number Theory, Additive Number Theory, Analytic Number Theory, Applications of Number Theory
Operations Research	Linear Programming, Nonlinear Programming, Stochastic Programming
Stochastics	Foundations of Probability Calculus, Martingals and Limit Theorems, Random Walk Analysis, Information Theory, Basic Concepts of Statistics and Estimation Theory, H

(5) Research Areas

- algebra and logic
- number theory
- analysis
- differential equations
- numerical methods
- operations research and its applications
- applied mathematics
- geometry
- discrete mathematics and computer science
- stochastics

(6) Description of the Main Research Areas of the Departments

Department of Algebra (Mathematical Institute, Faculty of Natural Sciences)

The main topics of the scientific research of the Department of Algebra are: algebraic and mathematical logic, automata theory, algebraic and arithmetical algorithms, group theory, computer algebra, semigroup theory, universal algebras, quasigroups, matrices, computer science, finite geometries and their applications in criptography.

Department of Analysis (Mathematical Institute, Faculty of Natural Sciences)

Strong research groups work on several mathematical aspects of quantum mechanics (as the differential geometry of the state space, quantum information theory, random matrices, spectral theory of Schrödinger operators, inverse potential scattering), on the functional analysis (operator theory, operator algebras, operator semigroups), on Fourier analysis, on approximation theory (growth properties of polynomials of several variables, potential theory, Hermite-Fejer interpolation). Linear systems and reaction kinetics are also investigated.

Department of Computer Science and Information Theory (Faculty of Electrical Engineering and Informatics)

The main focus is on discrete mathematics, mathematical foundation of computer science, number theory, information and coding theory, data mining, and their applications in engineering, in economics and in the development of cutting edge computer technologies

Department of Differential Equations (Mathematical Institute, Faculty of Natural Sciences)

The department conducts research on three larger, separate, fundamentally applied areas of mathematics.

In the area of differential equations most of the research is carried out regarding dynamical systems, ergodic theory, numerical dynamics, and bifurcation theory, as well as applications in biology, engineering and economics.

The results achieved in operations research concern mostly the topics of linear optimization, convex optimization, semidefinite optimization, interior point methods, integer programming, stochastic modelling and programming, combinatorial optimization, global optimization, multiobjective optimization and its applications, applications in economics, stochastic time series models and applications in statistics.

On the subject of numerical analysis, our colleagues focus on the numerical methods of ordinary and partial differential equations.

Department of Geometry (Mathematical Institute, Faculty of Natural Sciences)

Besides the differential geometry problem group (with central areas being investigation of mathematical questions and spaces induced by quantum physics, and Thurston and Minkowski spaces), there is an intensive ongoing research on discrete and combinatorial problems (primarily convex geometry questions). The two main research directions are connected vie computer graphics (problems of graphical visualization).

Department of Stochastics (Mathematical Institute, Faculty of Natural Sciences)

There are four active research groups at the Department of Stochastics:

Stochastic processes: On this field, there is an Academic Research Group at the Department. Research topics include: random walks, stochastic differential equations, percolation and complex networks.

Dynamical Systems: Billiards (dynamical systems with singularities), fractals and geometric measure theory.

Stochastic analysis: approximation of Brownian motions with random walks.

Statistics: we deal with both theory and applications of the mathematical statistics.

(7) Courses

The available courses, supervisors and thesis topics are always listed on the doctoral homepage at Courses menu.