

Training Plan -- SZTE Doctoral School of Mathematics

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1. Doctoral Training Programs

- Pure Mathematics

- Applied Mathematics
- Didactics of Mathematics

Within these, the main research areas cover algebra, analysis, dynamical systems, geometry, discrete mathematics, and stochastics.

2. Structure of the Doctoral Training

The doctoral training is fundamentally based on the **professional and trust-based relationship** between the doctoral student and the supervisor(s).

2.1. Doctoral Credits

The total number of credits to be earned during the doctoral training: **240**.

Before the official closure of each reporting period, the doctoral student prepares a **report** on the work completed for the Head of the Doctoral School, which is reviewed and signed by the supervisor.

At the Doctoral School of Mathematics, credits can be earned for **study, research, and teaching** activities as follows.

2.2. Study Credits

During the **first two years of the program**, the student must complete at least 5 courses, including at least 2 courses in the first year.

The Doctoral School announces the doctoral courses at the beginning of each semester. Each course (regardless of the number of hours, including reading courses) is worth **5 credits**. The list of regularly announced doctoral courses can be found in Section 3, "[Course Lists](#)".

Upon the doctoral student's request, participation in **online courses, summer or winter schools, or workshops** can be accepted as a course. The request must be submitted to the Head of the Doctoral School with the **support of the supervisor**.

2.3. Research Credits

The completion of research credits is certified by the supervisor.

Achievements related to research seminars, conferences, and publications can be credited multiple times within a semester. For achievements related to publications, in the case of co-authorship with another doctoral student, the credits may be divided by the Doctoral School Council.

The condition for submitting the doctoral dissertation for review is **at least two published or accepted publications** (including at least one journal article) related to the topic of the doctoral dissertation, published or accepted in a peer-reviewed journal indexed in an international database and published in a world language.

2.4. Teaching Credits

Teaching exercise session for one semester, **2 credits per weekly teaching hour**. A maximum of 8 credits can be earned per semester under this category.

The doctoral student must request the inclusion of teaching credits. The completion is verified and certified by the **teaching coordinator** of the Bolyai Institute.

3. Course Lists

3.1. Algebra

Course Name	Course Code
Group Theory	MATD1xx
Lattice Theory	MATD1xx
Semigroup Theory	MATD1xx
Universal Algebra	MATD1xx
Ordered Sets	MATD1xx
Clone Theory	MATD1xx
Finite Algebras	MATD1xx
Graph Homomorphism Problems	MATD1xx

3.2. Dynamical Systems

Course Name	Course Code
Partial Differential Equations	MMNV23E
Dynamical Systems	MMNV24E
Ordinary Differential Equations	MATD2xx
Functional Differential Equations	MATD2xx
Numerical Methods for Differential Equations	MATD2xx
Dynamical Models	MATD2xx
Nonlinear Dynamics	MATD2xx

3.3. Geometry

Course Name	Course Code
Algebraic Topology	MMNM42E
Combinatorics of Convex Polytopes	MMNM43E

Integral Geometry and Geometric Probability	MATD3xx
High-Dimensional Convex Geometry	MATD3xx
Brunn-Minkowski Theory of Convex Bodies	MATD3xx
Discrete and Combinatorial Geometry	MATD3xx
Stochastic Geometry	MATD3xx
Geometry of Vector Systems	MATD3xx
Selected Topics in Geometry	MATD3xx

3.4. Discrete Mathematics

Course Name	Course Code
Discrete Mathematics 2	MMNK51E
Extremal Graph Theory	MMNM55E
Mathematical Cryptography	MMNM56E
Combinatorial Computational Models	MMNM53E
Counting Problems	MATD4xx
Algebraic and Random Methods in Combinatorics	MATD4xx
Finite Geometries, Codes, Cryptography	MATD4xx
Selected Topics in Graph Theory	MATD4xx

3.5. Analysis

Course Name	Course Code
Measure and Integration Theory	MATD5xx
Complex Analysis	MATD5xx
Functional Analysis	MATD5xx
Banach Algebras and Operator Theory	MATD5xx
Selected Topics in Functional Analysis	MATD5xx
Approximation Theory	MATD5xx
Potential Theory	MATD5xx
Fourier Series, Fourier Integrals I	MATD5xx
Fourier Series, Fourier Integrals II	MATD5xx

3.6. Stochastics

Course Name	Course Code
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Probability Theory	MMNK61E
Stochastic Processes	MMNV63E
Financial and Risk Processes	MMNV64E
Statistical Analysis of Time Series	MMNV61E
Mathematical Statistics	MMNV62E
Markov Chains	MATD6xx
Branching Processes	MATD6xx
Selected Topics in Stochastics	MATD6xx

3.7. Didactics of Mathematics

Course Name	Course Code
Problem Solving in Mathematics and Mathematics Teaching	MATD7xx
Research Methodology and Applied Statistics	MATD7xx
Chapters from the Cultural History of Mathematics	MATD7xx
Elementary Combinatorics	MATD7xx
Digital Resources in Geometry Teaching	MATD7xx
Chapters from the Methodology of Teaching Higher Mathematics at Secondary and Tertiary Levels	MATD7xx

4. The Comprehensive Exam

During the doctoral training, at the end of the fourth semester, **as a conclusion of the training and research phase** and as a prerequisite for starting the research and dissertation phase, a comprehensive exam must be completed, which evaluates the academic and research progress.

The prerequisite for taking the comprehensive exam is earning **at least 90 credits during the training and research phase (first four semesters)** and completing all study credits required by the training plan of the Doctoral School. Exceptions are made for students preparing individually for the doctoral degree, whose student status is established upon successful completion of the comprehensive exam.

The comprehensive exam consists of **two main parts**: in one part, the candidate's **theoretical** knowledge is assessed (theoretical part), and in the other part, the candidate reports on their **scientific progress** (dissertation part).

In the first, theoretical part of the comprehensive exam, the candidate takes an exam in **two subjects, with two topics from one subject and one topic from the other**. The list of subjects and topics is provided in Section 5, "[Subjects of the Comprehensive Exam](#)". The theoretical exam may include a written component.

In the second, dissertation part of the comprehensive exam, the candidate gives a **presentation** on

their literature review, reports on their research results, presents their research plan for the second phase of the doctoral training, and outlines the schedule for completing the dissertation and publishing the results.

Before the exam, the supervisor evaluates the candidate in writing, addressed to the chair of the examination committee and sent to the secretary of the Doctoral School.

5. Subjects of the Comprehensive Exam

5.1. Universal Algebra and Lattice Theory

Topics

- i. Classical Algebraic Structures
- ii. Universal Algebra
- iii. Clones
- iv. Finite Algebra
- v. Lattice Theory
- vi. Coordinate Systems in Lattice Theory

5.2. Group and Semigroup Theory

Topics

- i. Finite Groups and Fields
- ii. Group Theory
- iii. Semigroup Theory
- iv. Regular Semigroups
- v. Universal Algebraic Studies of Semigroup Classes

5.3. Functional Analysis

Topics

- i. Functional Analysis
- ii. Measure and Integration Theory
- iii. Topological Vector Spaces
- iv. Banach Algebras
- v. Operator Theory

5.4. Classical Analysis

Topics

- i. Elements of Real Function Theory
- ii. Complex Analysis
- iii. Fourier Series
- iv. Fourier Integrals
- v. Orthogonal Series

5.5. Constructive Analysis

Topics

- i. Approximation with Trigonometric and Algebraic Polynomials
- ii. Function Spaces and Approximation Operators
- iii. Orthogonal Polynomials
- iv. Potential Theory and Applications

5.6. Differential Equations

Topics

- i. Basics of Ordinary Differential Equations
- ii. Basics of Partial Differential Equations
- iii. Dynamical Systems
- iv. Stability Theory
- v. Functional Differential Equations
- vi. Partial Differential Equations in Function Spaces

5.7. Geometry

Topics

- i. Convex Geometry
- ii. Discrete and Combinatorial Geometry
- iii. Combinatorics of Polytopes
- iv. Classical Integral Geometry
- v. Stochastic Geometry
- vi. Algebraic Topology

5.8. Discrete Mathematics

Topics

- i. Graph Theory
- ii. Set Systems
- iii. Block Systems and Codes
- iv. Counting Problems
- v. Complexity Theory
- vi. Combinatorial Methods in Geometry
- vii. Cryptography and Coding Theory

5.9. Stochastics

Topics

- i. Basics and Strong Laws of Probability Theory
- ii. Limit Theorems
- iii. Chapters from Mathematical Statistics
- iv. Stochastic Processes with Discrete State Space
- v. Stochastic Processes with Continuous State Space

5.10. Didactics of Mathematics

- 1. Goals of Mathematics Teaching, Learning Theories
- 2. Teaching Euclidean Geometry and Combinatorics
- 3. Teaching Elements of Algebra and Calculus
- 4. Teaching Elements of Probability and Statistics
- 5. History and Philosophy of Mathematics in Mathematics Education

6. Credit Distribution and Sample Curriculum in Tabular Form

6.1. Credit Table

Weekly Regular Consultation with Supervisor	10 credits
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Processing of Scientific Literature	10 credits
Survey of Research Problems	5 credits
Research Project Report	5 credits
Participation in Research Seminar (2 hours per week)	3 credits
Presentation at Research Seminar	3 credits
Presentation at Hungarian Conference	3 credits
Presentation at International (Foreign Language) Conference	5 credits
Technical Report	10 credits
Submission of Publication to Peer-Reviewed Journal in a World Language	15 credits
Final Acceptance of Publication in Peer-Reviewed Journal in a World Language	15 credits
Other Accepted Scientific Publication	10 credits

6.2. Sample Curriculum (Recommended)

Semester	1	2	3	4	5	6	7	8	Total
Studies									
Courses (credits)	10	5	5	5					25
Teaching (credits)	4	4	4	4	4	4			24
Research (can be taken once per semester)									
Processing of Scientific Literature; Technical Report; Weekly Regular Consultation with Supervisor (10 credits)	20	20	20	20					80
Survey of Research Problems; Research Project Report (5 credits)					5	10	10		25
Research (can be taken multiple times per semester)									
Participation in Research Seminar (2 hours per week); Presentation at Research Seminar; Presentation at Hungarian Conference (3 credits)				3	9	9			21
Presentation at International (Foreign Language) Conference (5 credits)						5	5		10
Submission of Publication to Peer-Reviewed Journal in a World Language (15 credits)							15	15	30
Final Acceptance of Publication in Peer-Reviewed Journal in a World Language (15 credits)								15	15
Other Accepted Scientific Publication (10 credits)					10				10
Total (credits)	34	29	29	32	28	28	30	30	240