



Master of Science in Mathematics

Outline of the program
2015 – 2017

National Research University
Higher School of Economics, Moscow

Moscow is one of the major research centers of the world and is a leading center of Russian mathematical research and education.

The Russian mathematical school is **one of the world's three leading mathematical schools**, along with those of the U.S. and France.

Of the 26 winners of the Fields Medal from 1990 to 2014, **seven** are alumni of Russian universities.

Faculty of Mathematics, HSE

The Higher School of Economics is a leading state-funded university in Russia.

The Faculty of Mathematics was established in **2008**, and since then it has become the most successful place in Russia for attracting researchers and students in Mathematics.

We offer undergraduate, Masters and PhD programs in Mathematics.

Collaboration with world-renowned research institutes in Russia:

- Steklov Mathematical Institute of the Russian Academy of Sciences
- Kharkevich Institute for Information Transmission Problems
- Lebedev Physical Institute of the Russian Academy of Sciences

Student exchange programs:

- École Polytechnique (*Paris*)
- Kyoto University

International cooperation agreements currently being prepared with:

- Leiden University
- University of Luxembourg
- University of Tokyo
- ETH Zurich
- École normale supérieure (*Paris*)
- University of Liverpool
- University of Nantes

Joint projects with the Independent University of Moscow:

- **Moscow Mathematical Journal**, one of the most frequently cited Russian mathematical journals
- **Math in Moscow**, an international student exchange/internship program

Two international research units of HSE affiliated with the Faculty of Mathematics:

- International Laboratory of Algebraic Geometry and its Applications (*Academic Supervisor – F. Bogomolov*)
- International Laboratory of Representation Theory and Mathematical Physics (*Academic Supervisors – A. Okounkov and R. Bezrukavnikov*)

The faculty and the laboratories have been actively hiring in recent years, and internationally renowned experts, with PhDs from **Harvard, Princeton, MIT, Paris Kyoto, Tokyo, Toronto, Montreal, Leiden, Bochum, Grenoble, Lyon, Marseille, Manchester**, have joined the faculty.

Our faculty is especially strong in the following research areas:

- Algebraic Geometry
- Dynamical Systems
- Topology
- Combinatorics
- Representation Theory and Mathematical Physics

Three faculty members were invited to speak at the International Congress of Mathematicians (Seoul, August 2014):

- Misha Verbitsky (*Algebraic and Complex Geometry*)
- Aleksandr Kuznetsov (*Algebraic and Complex Geometry*)
- Grigory Olshansky (*Combinatorics*)

For any mathematics department in the world, having invited speakers at the ICM is a great honor.

Faculty members – former speakers of the ICM:

- Boris Feigin (*Plenary*)
- Igor Krichever (*Mathematical Physics*)
- Victor Vassiliev (*Plenary*)
- Sergei Lando (*Combinatorics*)
- Yulij Ilyashenko (*ODEs and dynamical systems*)
- Alexey Rudakov (*Algebraic Geometry*)

The Board is very much impressed by the current state of academic affairs at the Department. Within 5 years of its creation, the HSE has become the leading Russian institution of higher learning in pure mathematics.

From the report of the International Advisory Board by Pierre Deligne, Sergey Fomin, Andrey Okounkov, Tetsuji Miwa, Stanislav Smirnov (September 2013)

Master of Science Program in Mathematics

The program in Mathematics aims to train professional researchers in mathematical sciences and experts in mathematical education.

Upon successful completion of the program, students

- will be prepared for PhD qualifying tests in Algebra, Topology and Analysis
- will have an independent research agenda and experience
- will have teaching experience at the university level

The **MSc program** takes **two full years** of study. All MSc students complete their Individual Study Plans (ISP). The **ISP** includes several mandatory items; however, most courses are chosen by students (students can choose from a certain number of special elective courses and a certain number of research seminars). A **course project** must be completed by the end of the first year. By the end of their course of study, students are required to submit a **Master's thesis**, including a presentation of thesis results in the form of a seminar. Every MSc student has a **faculty advisor**, who supervises the course project and the Master's thesis.

Applicants can expect to

- learn from leading experts in mathematics and mathematical physics
- take advantage of a great variety of mathematical events happening in Moscow
- choose to combine our MSc program with an international MSc or integrated graduate programs
- take advantage of our student exchange programs with universities in France and Japan
- choose from a wide range of special elective courses and research seminars
- continue their research in our PhD program or in any international PhD program in mathematics
- benefit from a uniquely stimulating, dynamic and supportive learning environment
- discover the rich and fascinating cultural life of Moscow

For outstanding applicants, we offer

- free tuition
- 99-percent reduction on the cost of accommodation
- scholarships
- a limited number of teaching assistantships, research assistantships, and travel grants

Application Requirements

Mandatory items:

- **A Statement of interest**, including a description of a mathematical subject that is interesting to the applicant, and a list of mathematical books, articles, and other materials that the applicant has recently read, mathematical events that the applicant has attended (e.g., summer schools, public lectures, and mathematics courses outside the home university/college). The statement of interest must be written by the applicant in English (recommended length is 1-2 pages). This is a formal communication – please make it meaningful and avoid trivialities.
- **Recommendation letters** (one required, two recommended) from a project advisor and/or a faculty member who is familiar with the applicant's mathematical achievements. Recommendations can be written in English or Russian. Applicants should ask their recommenders to e-mail the letters directly to the international admissions office (inter@hse.ru).
- **Documents** listed at www.hse.ru/international/gradadm, to be sent to the international admissions office at inter@hse.ru or as indicated in the site given above.

Optional supplementary items:

- **Course projects in Mathematics or Physical Sciences**, and projects that are not part of a regular university curriculum. Written original texts by the applicants, both of research type and reference type (e.g., articles), must be sent in PDF format.
- **Diplomas or certificates** confirming the applicant's mathematical honors and awards (for winners of student Olympiads, research project competitions, etc.), academic scholarships and grants received by the applicant. Please attach the scanned versions to your e-mail application.

There is no application fee.

Structure of the Syllabus

The Master of Science program in Mathematics is aimed at students who plan an academic career in Mathematics, Science or Mathematical Education. The program takes two full years of study and is worth 120 ECTS credits (including all courses, course projects, teaching and research practice, and preparation of the Master's thesis).

The program is conducted in English; however, some optional courses taught jointly with other educational programs may be in Russian.

Joint courses with the Math in Moscow program are taught in English only.

The following are the only mandatory courses (all students must take them):

- Mathematical Methods of Science, *Fall 2015*
- History of Mathematics, *Spring 2016*
- Mathematical Experiments, *Spring 2016*
- Graduate Student Seminar, *Full year*

These courses must be taken in the first year of study (2015–2016). The Graduate Student Seminar must be taken in the second year of study (2016–2017) as well.

All other courses are optional and can be taken either in 2015–2016 or in 2016–2017. An optional course is offered as regular course with classroom hours provided that at least seven students are officially registered. If fewer than seven students are registered for the course, the course is taught as a reading course (no classroom hours).

The following is a pool of optional courses offered in English by the Faculty of Mathematics. They are grouped according to the subject area.

Analysis, probability and dynamical systems (APDS)

- **Complex analysis**
- **Ordinary differential equations**
- Introduction to probability
- Stochastic dynamics and ergodic theory
- Functional analysis
- Equations of mathematical physics
- Partial differential equations and distributions
- Introduction to dynamical systems
- Analysis of several complex variables
- Integrable systems

Algebra, logic and number theory (ALNT)

- **Basic algebra**
- **Advanced algebra**
- **Basic representation theory**
- Commutative algebra
- Introduction to number theory
- Arithmetic/diophantine geometry
- Logic and computability
- Lie groups and Lie algebras
- Sheaves and cohomology

Geometry and topology (GT)

- **Topology I**
- **Topology II**
- Riemann surfaces
- Differential geometry
- Algebraic geometry: a start-up course
- Differential topology
- Symplectic geometry and topology
- Singularity theory
- Hodge theory and complex algebraic geometry
- Riemannian geometry

Miscellaneous

- Academic writing

All of these are semester courses that may be offered in either the spring or fall. Each of these courses is taught in 2015 or in 2016.

Courses marked in bold are offered jointly with the Math in Moscow program but are conducted by the Faculty of Mathematics. These courses are offered every year provided that there are at least seven registered students.

The other courses may or may not be repeated every year.

Students normally focus on one subject area (called the major specialization) but are also required to take courses from different fields. Students are expected to take at least one semester course from each subject area (APDS, ALNT, GT) every year.

Further Opportunities

The Faculty of Mathematics has a 3-year PhD program that is free for everybody. Students who wish to enter this program are required to pass an entrance exam. International PhD programs in Mathematics are also offered by the Institute of Information Transmission Problems and the Steklov Mathematical Institute of the Russian Academy of Sciences (both institutes are in Moscow). They focus on fundamental and applied research.

The graduates of the Faculty of Mathematics have entered PhD programs at the following universities:

- Harvard University
- Princeton University
- Columbia University
- MIT
- Yale University
- University of Toronto
- University of Michigan, Ann Arbor
- University of Maryland
- Leibnitz-Universität Hannover
- Université Nice Sophia Antipolis

Mathematical Life in Moscow

Intensive mathematical activity takes place in the following Moscow institutions:

- Faculty of Mathematics, HSE
(www.math.hse.ru/en)
- Independent University of Moscow
(ium.mccme.ru/english)
- Steklov Mathematical Institute
(www.mi.ras.ru)
- Faculty of Mechanics and Mathematics, MSU
(www.msu.ru/en)
- Institute for Information Transmission Problems
(www.iitp.ru/en/about)

All of these places regularly host important mathematical events that are open to the public.

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