

# Doctor of Philosophy in Mathematics

## Why study mathematics?

Because mathematics is a framework upon which humanity builds an understanding of the world.

## Mission of the Graduate Program:

The mission of the Graduate Program of the Department of Mathematics is to prepare students for leadership roles in meeting the mathematical needs of our society and to produce professional mathematicians for positions in universities, colleges, industry, governmental agencies, and research centers.

## Doctor of Philosophy in Mathematics:

The Mathematics Department offers the degree of Doctor of Philosophy (Ph.D.) in Mathematics. The Ph.D. program provides broad and deep expertise in mathematics, culminating in a dissertation that includes significant original work. It is intended for students with a strong mathematical background who plan a career in research in academia or industry. A broad range of specialties is possible; research interests of department faculty include algebra, analysis, combinatorics, control theory, dynamical systems, geometry, numerical analysis, partial differential equations, probability, and statistics. College-wide requirements for graduate students may be found in the Graduate School Catalog (<http://catalog.ku.edu/liberal-arts-sciences/#graduatetext>).

## Admission to Graduate Studies

### Admission Requirements

- All applicants must meet the requirements outlined in the Admission to Graduate Study (<https://policy.ku.edu/graduate-studies/admission-to-graduate-study/>) policy.
- Bachelor's degree: A copy of official transcripts showing proof of a bachelor's degree (and any post-bachelor's coursework or degrees) from a regionally accredited institution, or a foreign university with equivalent bachelor's degree requirements is required.
- English proficiency: Proof of English proficiency (<https://gradapply.ku.edu/english-requirements/>) for non-native or non-native-like English speakers is required. There are two bands of English proficiency, including Admission and Full proficiency. For applicants to online programs, Full proficiency is required.

## Admission to the Ph.D. in Mathematics

The minimum prerequisites for admission are:

- an undergraduate degree from an accredited institution with a program of study in mathematics;
- a record of achievement that shows strong promise of success in graduate school, including a 3.0 cumulative grade-point average in undergraduate studies and a 3.0 grade-point average in mathematics (department requirement);
- course work in abstract algebra, linear algebra, and advanced calculus or introduction to analysis (comparable to KU courses MATH 500, MATH 558, and MATH 590).

It is beneficial to have preparation in probability/statistics (comparable to MATH 627/MATH 628) and/or numerical analysis (comparable to MATH 581). Although not required, it is also helpful to have taken introductory courses in complex analysis (comparable to MATH 646), partial differential equations (comparable to MATH 647), geometry (comparable to MATH 660/MATH 661), and/or topology.

The Mathematics Department currently does not require the general or subject Graduate Record Examination (GRE). International students whose native language is not English must fulfill English language requirements specified by university policies.

Applicants must submit a graduate application online (<https://gradapply.ku.edu/apply/>), including the following required materials:

- Transcript from each college or university the applicant has attended (an official transcript must be sent upon acceptance and completion of degree).
- Applicant's résumé/curriculum vitae.
- A list of the textbooks used in mathematics courses beyond calculus.
- A statement of purpose indicating the applicant's mathematical preferences and interests.
- 3 letters of reference.

Incomplete applications will not be considered. The minimum admission requirements do not guarantee admission. The Department of Mathematics evaluates candidates and makes recommendations to the Office of Graduate Studies regarding admission. The number of students admitted to the program changes from year to year, and admissions are competitive based on all application materials.

There are no additional application forms for financial support. Students are considered for support based on merit. Most Ph.D. students accepted by the program receive an offer of financial support in the form of a Graduate Teaching Assistantship. The number of GTAs available is limited. Further information about applications and admissions is available from the Department of Mathematics (<https://math.ku.edu/admission-graduate-program/>).

Contact the department:

**Michelle Morrison**  
**Graduate Program Coordinator**  
**Department of Mathematics**  
**433 Snow Hall**  
[michmor@ku.edu](mailto:michmor@ku.edu)

## Ph.D. Degree Requirements

### Course Work Requirements

Complete the course requirements as indicated below.

Code	Title	Hours
<b>Qualifying Exam Course Work</b>		<b>12</b>
Probability & Statistics <sup>1</sup>		
MATH 727	Probability Theory	
or MATH 866	Stochastic Processes II	
Analysis <sup>1</sup>		
MATH 765	Mathematical Analysis I	
or MATH 800	Complex Analysis I	
or MATH 810	Real Analysis and Measure Theory I	

Numerical Analysis <sup>1</sup>

MATH 781 Numerical Analysis I

or MATH 881 Topics in Advanced Numerical Linear Algebra: \_\_\_\_\_

or MATH 882 Topics in Advanced Numerical Differential Equations: \_\_\_\_\_

Algebra <sup>1</sup>

MATH 791 Modern Algebra

or MATH 830 Abstract Algebra

Qualifying exam course work must be completed before the preliminary exam.

## Additional Required Course Work

MATH 800 Complex Analysis I 3

MATH 810 Real Analysis and Measure Theory I 3

One of the following sets of three courses: 9

## Option 1

MATH 830 Abstract Algebra

MATH 820 Introduction to Topology

or MATH 821 Algebraic Topology I

MATH 840 Differentiable Manifolds

or MATH 92 Lie Groups and Lie Algebras

## Option 2

MATH 840 Differentiable Manifolds

or MATH 85 Differential Equations and Dynamical Systems

or MATH 95 Partial Differential Equations

Choose one of the following two course sequences:

MATH 850 Differential Equations and Dynamical Systems  
& MATH 851 and Topics in Dynamical Systems: \_\_\_\_\_MATH 865 Stochastic Processes I  
& MATH 866 and Stochastic Processes IIMATH 881 Topics in Advanced Numerical Linear Algebra:  
& MATH 882 \_\_\_\_\_and Topics in Advanced Numerical Differential  
Equations: \_\_\_\_\_Four additional MATH courses at the 800 or 900 level, not including  
MATH 896, MATH 899, MATH 993, or MATH 999. <sup>2</sup> 12**Total Hours** 39<sup>1</sup> Passing a qualifying exam in Probability & Statistics, Analysis, Numerical Analysis, or Algebra exempts a student from the corresponding qualifying exam course work.<sup>2</sup> MATH 990 and/or courses outside Mathematics may be used to satisfy this requirement only with Graduate Committee approval.

## Qualifying Examinations

Pass two written qualifying examinations: one exam in either algebra or analysis and a second exam in either numerical analysis or probability/statistics. Both qualifying examinations must be completed by the beginning of the student's fifth semester. This requirement must be completed before the preliminary examination. Students who do not meet this requirement will not be able to continue in the Ph.D. program and will be moved to the M.A. program.

Students will be awarded a master's degree in mathematics as soon as the master's degree requirements, as outlined in the academic catalog

(<https://catalog.ku.edu/liberal-arts-sciences/math/ma/#requirementstext>), have been met.

## Preliminary Exam

Pass a preliminary examination in an area close to the focus of the eventual doctoral dissertation. The preliminary examination may be written, oral, or a combination of both. A preliminary examination committee of at least three faculty members, including the advisor, will decide on the form of the exam, and give the student an outline of topics and suggested readings. The committee will then design the exam and evaluate the student's performance. The preliminary examination must be completed by the beginning of the student's eighth semester.

## Research Skills and Responsible Scholarship

The University requires that every doctoral student receive training in responsible scholarship pertinent to the field of research and obtain research skills pertinent to the doctoral level of research in their field(s). These requirements must be completed by the end of the semester that the student takes the oral comprehensive exam.

For students in the Mathematics PhD program, the **Research Skills requirement** is satisfied in one of three ways:

1. Successfully completing EECS 138 or EECS 168 at KU;
2. Providing proof of completion of an introductory programming language course from a non-KU institution, either at the graduate or undergraduate level. Students wishing to fulfill the requirement must submit a request to the Graduate Committee for approval;
3. Completing a computing project approved by their advisor and the Graduate Committee demonstrating competence in either a programming language or the use of specialized software that supports the student's research.

The **Responsible Scholarship requirement** is satisfied by completing the departmental training in responsible scholarship for mathematicians. The training is offered every spring semester by a graduate faculty member, typically the director of graduate studies, and students must have passed the qualifying exams and be working with an advisor in order to participate. The graduate faculty member leading the training will offer a seminar to introduce responsible scholarship topics relevant to mathematics. Topics include: authorship, publication, plagiarism, copyright, peer review, refereeing, grant proposal preparation, professional practices, conflict of interest, maintenance of confidentiality, and student-mentor relations and responsibilities.

## Electives

A list of available electives is below. Please note that any class taken to satisfy one of the requirements noted above cannot also double-count as an elective:

Code	Title	Hours
MATH 802	Set Theory	3
MATH 820	Introduction to Topology	3
MATH 821	Algebraic Topology I	3
MATH 824	Algebraic Combinatorics	3
MATH 830	Abstract Algebra	3
MATH 831	Abstract Algebra II	3
MATH 840	Differentiable Manifolds	3
MATH 850	Differential Equations and Dynamical Systems	3

MATH 851	Topics in Dynamical Systems: _____	3
MATH 865	Stochastic Processes I	3
MATH 866	Stochastic Processes II	3
MATH 874	Statistical Decision Theory	3
MATH 881	Topics in Advanced Numerical Linear Algebra: _____	3
MATH 882	Topics in Advanced Numerical Differential Equations: _____	3
MATH 890	Fourier Analysis	3
MATH 910	Algebraic Curves	3
MATH 920	Lie Groups and Lie Algebras	3
MATH 940	Advanced Probability	3
MATH 950	Partial Differential Equations	3
MATH 951	Topics in Advanced Partial Differential Equations II: _____	3
MATH 960	Functional Analysis	3
MATH 961	Topics in Functional Analysis: _____	3
MATH 996	Special Topics: _____	3

## Oral Comprehensive Exam

Once the student has passed their qualifying exams and completed the required coursework (both regular coursework and exam coursework as indicated above), preliminary exam, and research skills and responsible scholarship requirements, they can proceed with taking the comprehensive oral examination. Typically, the work required to prepare a student for the oral comprehensive examination (and to do research) includes one or more semesters of advanced courses, directed readings, and seminars. In the examination, a student will be required to show proficiency in their chosen area of mathematics. The subject matter and format will be determined by the student's advisory committee and must be communicated to the student in advance. For more information please see the full Graduate Studies policy on Doctoral Degree Comprehensive Oral Exams. (<https://policy.ku.edu/graduate-studies/doctoral-oral-exams/>)

## Post-Comprehensive Enrollment

Upon passing the comprehensive examination, the student becomes a candidate for the Ph.D. degree and is approved to proceed with their dissertation research and project. Starting the semester following successful completion of the oral comprehensive exam, students must enroll in accordance with the Office of Graduate Studies' Doctoral Candidacy Policy. This enrollment includes, but is not limited to, at least 1 dissertation hour (MATH 999) every semester until graduation. For more information, please see the full Graduate Studies policy on Doctoral Candidacy ([https://policy.ku.edu/graduate-studies/doctoral-candidacy/#:~:text=Doctoral%20candidates%20are%20required%2C%20after%20passing%20the%20comprehensive%20oral%20examination,possible%20the%20candidate%E2%80%99s%20demands%20on%20faculty%20time%20and%20university%20facilities](https://policy.ku.edu/graduate-studies/doctoral-candidacy/#:~:text=Doctoral%20candidates%20are%20required%2C%20after%20passing%20the%20comprehensive%20oral%20examination,possible%20the%20candidate%E2%80%99s%20demands%20on%20faculty%20time%20and%20university%20facilities).)).

## Dissertation

Following successful completion of the comprehensive oral examination, the candidate must write a dissertation on their chosen topic under the supervision of a dissertation committee. The dissertation must be an original work of research that advances the field of mathematics and complies with the Office of Graduate Studies' Doctoral Dissertation policy (<https://policy.ku.edu/graduate-studies/doctoral-dissertation/>).

## Final Oral Examination

Upon approval by the student's committee that the student's dissertation research and written document is complete, the student must defend the dissertation before all committee members in the final oral examination. The final oral examination includes a public presentation of the dissertation research by the candidate and concludes with a period of questioning by the committee. After posing questions to the student about the dissertation work, committee members deliberate and vote on a grade of satisfactory or unsatisfactory. A grade of satisfactory requires a majority vote, and may be contingent on the completion of specific revisions by a designated due date. The committee may also recommend that a student earning a satisfactory grade be considered for honors by the department. Honors are conferred at graduation by the department, reflecting outstanding work in all aspects of the doctoral program.

At the completion of this program, students will be able to:

- Demonstrate expertise in mathematics, including familiarity with major areas of pure and applied mathematics, and accomplish original work in a chosen area of specialization.
- Communicate mathematics effectively both orally and in writing.
- Understand and uphold professional standards for mathematicians, including research conduct and ethics.
- Prepare for a professional career in the mathematical sciences in academia or industry.