

# MATHEMATICS, PH.D.

The PhD degree in Mathematics is intended as a research degree and is awarded based on scholarly proficiency (as demonstrated by course work and the written Qualifying Exams or the Comprehensive Exam) and the ability to conduct independent, original research (demonstrated by the PhD dissertation).

## Admissions

The Doctor of Philosophy degree in Mathematics is intended as a research degree and is awarded based on scholarly proficiency (as demonstrated by course work and the Qualifying Examination) and the ability to conduct independent, original research (demonstrated by the PhD dissertation).

In addition to the minimum Graduate School admission requirements, to be considered for regular admission an application must include:

- A resume/CV
- 3 letters of recommendation.

Scores on the general test of the GRE are optional. We encourage applicants to submit GRE scores if they think doing so will boost their chance of getting admitted. However, applications with and without GRE scores will both get full consideration.

See the Admission Criteria section of this catalog for more information.

## Curricular Requirements

Students must complete 48 credit hours of graduate level courses with a minimum of 39 hours in mathematics. All math courses starting with 50 and the following courses do not count toward this degree: MATH 530 Data Science and Programming, MATH 551 Math Stats W/Applictn I, MATH 552 Math Stats W/Applictn II, MATH 570 Prin Modern Algebra I, MATH 572 Advanced Linear Algebra, MATH 585 Intro Complex Variables, MATH 586 Intro Real Analysis I, MATH 587 Intro Real Analysis II, and MATH 591 Teaching College Math (except Math Education students).

Most of the courses required for a master's degree, but not all, are part of the approved collection. The student's program of study must be approved by the Graduate Program Director, in consultation with the student's dissertation advisor. Sample study plans for students wishing to focus in Algebra, Analysis, Scientific Computing, PDE, Topology, Math Education, or Optimization can be found in the Graduate Student Toolkit.

Coursework Requirements	Hours
<b>Qualifying Exam Sequences (Choose 2)</b>	<b>12</b>
Algebra	
MATH 571 Prin Modern Algebra II & MATH 573and Abstract Algebra I	
Boundary Value Problems and Partial Differential Equations	
MATH 541 Boundary Value Problems & MATH 642and Partial Diff Equations I	
Numerical Analysis	
MATH 511 Numerical Analysis I & MATH 512and Numerical Analysis II	
Real Analysis	
MATH 680 Real Analysis I & MATH 681and Real Analysis II	
Topology	

MATH 565 Intro General Topology  
& MATH 566and Intro Algebraic Topology

**Additional Sequences** **6**

Students need to take one more sequence, from either the qualifying exam sequences or the following additional sequences.

Mathematical Statistics

MATH 554 Advanced Math Statistics I  
& MATH 555and Advanced Math Statistics II

Optimization

MATH 520 Linear Optimization Theory  
& MATH 521and Non-Linear Optimization Theory

**Additional Courses (choose 10)** **30**

Besides the sequences, additional courses are available to students that provide the foundation to do research at the PhD level.

MATH 510 Numerical Linear Algebra
MATH 538 Topics in Mathematics
MATH 557 Stochastic Processes I
MATH 559 Stochastic Processes II
MATH 560 Intro Differential Geom
MATH 588 Theory Diff Equations I
MATH 593 Collegiate Math Education Rsrc
MATH 597 Directed Individual Studies
MATH 598 Non-Thesis Research
MATH 610 Iterative Meth Linear Sys
MATH 611 Numerical PDEs
MATH 638 Advanced Topics in Mathematics
MATH 643 Partial Diff Equations II
MATH 648 Topics in PDE
MATH 661 Algebraic Topology I
MATH 674 Abstract Algebra II
MATH 677 Topics Algebra I
MATH 683 Complex Analysis I
MATH 684 Complex Analysis II
MATH 686 Functional Analysis I
MATH 688 Topics in Analysis
MATH 697 Directed Studies: Adv Topics
MATH 698 Non-Dissertation Research

**Dissertation** **18**

MATH 699 Dissertation Research

**Total Hours** **66**

## Transfer Credit

See the Graduate School policy.

## Doctoral Plan of Study Requirement

See the Graduate School Policy on the Doctoral plan of study.

## First Year Coursework and Preliminary Examination

All first year PhD students are required to attend a weekly seminar about first year experience of graduate school, led by a full or associate graduate faculty member. In addition, they are required to take two master's core sequences:

- (1) MATH 586 Intro Real Analysis I, MATH 587 Intro Real Analysis II, and either
- (2a) MATH 572 Advanced Linear Algebra and MATH 570 Prin Modern Algebra I, or
- (2b) MATH 572 Advanced Linear Algebra and MATH 530 Data Science and Programming.

For MATH 572 and MATH 586, in addition to regular lectures there are also weekly discussion sessions led by TA. Students must attend the discussion sessions as well as the lectures. Students are required to obtain at least a grade of B and at least 75% in the final exams of all master's core courses. Those who do not will be required to take the corresponding preliminary exams in the August after the first year. Students may also test out of these two core sequences by taking and passing the corresponding preliminary exams.

The final exams for MATH 586, MATH 587, MATH 572, MATH 570, and MATH 530 will be prepared and graded by exam committees appointed by the Graduate Program Committee, in consultation with the department chair. Each course will have an exam committee consisting of three members: the instructor of the course and two additional faculty members. All three members must be full or associate members of the graduate faculty.

In the first fall semester, all students who are supported as GTA must take MATH 502 Teaching Workshop and two regular graduate courses, MATH 586 and MATH 572. Students who are supported as GRA are not required to take MATH 502, but are required to take at least two regular courses (MATH 586, MATH 572), and are recommended to take one more regular course. Students who are supported by fellowships are not required to take MATH 502 but are required to take at least three regular courses (MATH 586, MATH 572, and one more regular course).

The math department offers three preliminary exams (PEs):

- Analysis Exam that is based on MATH 586 and MATH 587.
- Linear Algebra and Data Science and Programming Exam that is based on MATH 572 and MATH 530.
- Linear Algebra and Principles of Modern Algebra Exam that is based on MATH 572 and MATH 570.

The PEs are offered once a year in August and are prepared and graded by the exam committees for MATH 586, MATH 587, MATH 572, MATH 570, MATH 530, respectively. Students must receive 75% or above to pass the preliminary exams. First year students can choose to test out of one or both master's core sequences by taking and passing one or both PEs on arrival. If they pass one or both PEs, then they are exempted from taking the corresponding courses. Otherwise, they must take the courses.

PhD Students must either test out of the master's core sequences, or get at least a B and receive at least 75% in the final exams of all of the corresponding courses, or pass the corresponding PEs by the August after their first full academic year of PhD studies in the Department of Mathematics at The University of Alabama; those who do not will

not be able to continue in the PhD program and will have to transfer to the master's program.

## The PhD Qualifying or Comprehensive Exams

PhD students must fulfill one of the following two options no later than the August after their third year of PhD studies in the Department of Mathematics at The University of Alabama; those who do not will not be able to continue in the PhD program. They may choose to move to the master's program.

**Option 1:** Pass two written qualifying exams from five subjects: Algebra, Topology, Real Analysis, Numerical Analysis, and Partial Differential Equations.

Written qualifying exams are given twice a year, in January and August respectively, lasting four hours each. Students may take no more than two qualifying exams at a time, and they have at most three attempts in each qualifying exam. Although not recommended, it is allowed for students to take different subjects in different testing periods. However, doing so will not extend the deadline of passing two exams beyond the August after their third year. If a dispute arises, the final interpretation of the exam rules and scores will be made by the Graduate Program Committee.

Each exam is written and graded by a committee appointed by the Graduate Program Committee, in consultation with the department chair. To guarantee independence and avoid conflict of interests, each committee will, if possible, consist of two faculty members who are not instructors of the corresponding courses in that year. The committees must seek input from the instructors on the preparation of the exams. After the qualifying exams are graded, the exam committees make a recommendation of a grade of Fail or Pass to the GPC and the Graduate Program Director. The GPC will have the final authority to assign the grade, which is then conveyed to each student by the Graduate Program Director, who will also inform the graduate school. The full grade will also be available to potential advisors.

**Option 2:** Pass a comprehensive exam that is based on the plan of study.

Instead of taking two written qualifying exams, students may choose to take a comprehensive exam led by their dissertation advisors. Students who want to choose this option must satisfy the following conditions:

- (a) They must have a dissertation advisor by the end of their third semester.
- (b) The dissertation advisor must be willing to form a dissertation committee and lead the committee to design a comprehensive exam that covers topics in the student's plan of study, emphasizing topics most relevant to their research.

The committee can decide whether the comprehensive exam is written or oral. It is up to the committee to choose a time to test the students. Under Option 2, each student has a maximum of three attempts in the comprehensive exam. As always, students have the freedom to change areas of research, dissertation advisors, or members of their dissertation committee. However, if changing advisors, at the discretion of the new advisor, the student may need to retake the comprehensive exam. In addition, changing areas, advisors, or committee members do not give students an extension of the deadline to pass the comprehensive exam by the August after their third year.

## PhD Dissertation Committee Requirements

Students need to decide on a major area of specialization, and find an advisor in that area. This should happen no later than the beginning of the third year. Although the Graduate Program Director will assist students in choosing a dissertation advisor, students are in the end responsible for finding a dissertation advisor. Students must form a dissertation committee consisting of at least five members, with at least three from the Department of Mathematics of UA and at least one from outside the Department of Mathematics of UA, possibly outside of UA. Note that they all need to be graduate faculty. Contact the Graduate Program Director about requesting temporary graduate faculty membership for non UA faculty. The dissertation advisor must be a full member of graduate faculty of the Department of Mathematics of UA and serve as the committee chair.

## Admission to Candidacy Requirements

Advancing to candidacy requires the passing of either two qualifying examination or one comprehensive exam, the completion of all the coursework as listed on the approved plan of study, and successfully presenting and defending a dissertation proposal. In a formal meeting, students present their dissertation research proposal to the dissertation committee in which students should demonstrate they have meaningful directions of research to pursue and a good foundation for research. The committee will assess the worthiness of the research proposal and approve or disapprove it. Students should fulfill all PhD candidacy requirements by the end of their fourth year.

## Continuous Enrollment Policy

See the Graduate School policy.

## Dissertation Requirements

See the Graduate School policy.

## Time Limits for Degree Completion Requirements

See the Graduate School policy.

## Student Progress Requirement

The following is a satisfactory progress toward a PhD in Mathematics.

- 1st Year – Complete two master's core sequences with a grade of B or better and at least 75% in the final exams in all master's core courses, or pass the corresponding preliminary exams, and maintain a 3.00 GPA or higher.
- 2nd Year – Discuss with the initial advisor to create a PhD plan of study, complete at least two 2-course PhD sequences with a satisfactory GPA, and find a dissertation advisor.
- 3rd Year – Maintain a satisfactory GPA, pass either two written qualifying exams or one comprehensive exam no later than the August after their third year.
- 4th Year – Determine a potential dissertation topic, form a dissertation committee, prepare the dissertation proposal and defend it in front of the dissertation committee by the end of the fourth year. Obtain approval of the research proposal from the dissertation committee and begin dissertation research. Also, complete the 48 hours with a satisfactory GPA. Request the Plan of Study form and the Admission to Candidacy form by contacting the Graduate Program Assistant.

- 5th Year – Check the student deadlines from the graduate school's website. At least one month before the deadline for submission of the dissertation to the graduate school, students must distribute a hardcopy of their dissertation to committee members, and the defense needs to be scheduled to give students at least one week to make corrections.
- Provided satisfactory progress towards the PhD is being made, a student's advisor may request an extension for a 6th year of support. This request must be made before the end of the semester before the last semester of funding.

## Academic Misconduct Information

See the Graduate School Policy.

## Withdrawals and Leave of Absence Information

See the Graduate School Policy.

## Academic Grievances Information

See the Graduate School Policy.

## Grades and Academic Standing

See the Graduate School Policy.

## Graduate School Deadlines Information

See the Graduate School Deadlines.

## Application for Graduation Information

See the Graduate School Policy on application for graduation.

Financial assistance is available to all graduate students on a competitive basis, and is subject to availability of funding, continued good progress towards obtaining a degree and a good employment record. The forms of financial assistance usually include graduate teaching assistantships (GTA), graduate research assistantships (GRA), and fellowships. The offer of any assistantships is contingent upon receipt of acceptable results on a pre-employment background report.

Eligible students who excel in the program may be nominated by the Department for UA fellowships. Nominees are selected by a committee consisting of departmental faculty, and are based upon prospective nominee research productivity, academic performance, and contributions to the Department.

## Stipend and Benefits of Graduate Teaching Assistants

The appointment as a Graduate Teaching Assistant (GTA) pays a monthly stipend that is equally distributed through the academic year (fall and spring). It also provides a 100% full-time tuition scholarship for up to 15 credits in each of the fall and spring semesters, a single coverage health insurance, and payment of college and departmental fees. The stipend and amounts used to pay health insurance and college and departmental fees are taxable. All amounts are subject to change by The University of Alabama Trustees.

Continuation of the GTA position at any time is contingent upon continued enrollment in the PhD program in mathematics, the availability of funding, satisfactory progress toward the degree objectives, remaining in academic good standing, and satisfactorily completing the duties associated with this assistantship.

## Duties of Graduate Teaching Assistants

Each GTA will be required to work 20 hours per week under the supervision of the Graduate Program Director. This constitutes a full-time equivalency appointment (FTE) of 0.50 (50%). The specific assignments and duties, determined by the supervisor, will be included in the Memorandum of Appointment.

The workload for a GTA (with 0.50 FTE) is six credits of teaching per semester. This translates into the teaching of two 3-credit courses (0.25 FTE each), or an equivalency of the combination of classroom and non-classroom duties. The workload for a half GTA (with 0.25 FTE) is the teaching of one 3-credit course (0.25 FTE), or an equivalency of the combination of classroom and non-classroom duties.

With the approval of the Graduate Program Director and the Department Chair, lower division courses are assigned by the Director of Lower Division Instruction, and tutoring/proctoring duties are assigned by the Supervisor of Tutors and Proctors. GTAs need to talk to the Graduate Program Director if they have concerns about their duty assignments.

## Performance Expectations for Continuing Financial Support

Because a PhD usually requires at least five years of full-time study, financial support is ordinarily provided for a duration of five years. A sixth year of funding is made available on a case by case basis. Requests for extensions of financial support into the 7th year or above are generally not considered.

All the following requirements must be met for financial support to be renewed.

1. Students must carry out the teaching and/or other duties assigned to them by the department and the university.
2. Students must meet the following expectations on academic progress:
  - a. Students must maintain a 3.0 GPA or better throughout the program.
  - b. Students must satisfy the first year coursework and preliminary exam requirements by the start of the second year.
  - c. Students must pass either two written qualifying exams or the comprehensive exam by the start of their fourth year.
  - d. Students must have a dissertation proposal that is approved by their dissertation committee by the start of their fifth year.
  - e. Students must report substantial progress in their dissertation research work to their dissertation committee by the end of the fifth year.

If all above requirements are satisfied and the student's advisor is content with the student's progress, the advisor may request an extension for a 6th year of support. This request must be made before the end of the semester before the last semester of funding.

## Conditions for Termination of Financial Support

Students who meet one or more of the following criteria will result in prorated stipend, the termination of their assistantships, or the suspension from the graduate program.

1. Failing to carry out the teaching and/or other duties assigned to them by the department and the university. Examples of failing to carry out duties include, but are not limited to

- a. Failure to teach assigned classes or perform assigned duties in the MTLC.
  - b. Failure to consult with course coordinator or the Director of Lower Division Instruction about changes to their courses.
  - c. Failure to consult with the Supervisor of Tutors and Proctors or the MTLC Lab Coordinator about changes to MTLC schedules or duties.
  - d. Leaving before the end of the semester (defined as the date grades are due) or returning after the Monday before classes start without permission of the MTLC Lab Coordinator and the Graduate Program Director.
2. Failing to meet the expectations on academic progress described in Performance Expectations for Continuing Financial Support.
  3. Resolved finding of Academic Misconduct. Penalties, including potential loss of financial support, will be determined with guidance from the UA Graduate School and/or the UA College of Arts and Sciences.