Ph.D. in Mathematics

Students in mathematics are expected to develop competence in real and complex analysis and at least two areas chosen from applied mathematics, dynamical systems, functional analysis, numerical analysis, partial differential equations, probability, topology or other topics the student’s committee may approve. The student’s graduate committee determines additional requirements. General degree requirements are given below. For additional information about the program, please refer to http://www.math.montana.edu/.

PhD Admission Requirements

Admission to the program is based on an assessment of the total academic record and demonstrated promise to complete a doctoral degree in mathematics using a holistic approach. The minimum requirements to be considered for admission are a B.S. degree from an accredited college or university in the U.S. or its equivalent from a foreign institution, and an overall grade-point average of 3.0 (B) in your most recent two years of study.

Prerequisites for the Ph.D. degree program in mathematics consist of the following course work or their equivalent if the student is coming from another institution. Please refer to the MSU course description within each link for a list of topics covered in the courses. Rigorous advanced undergraduate courses or M.S. level courses in the areas listed below. Ideally, these courses have a strong emphasis on writing proofs so that the applicant has depth of understanding in both subjects.

1. Adequate academic performance in Principles of Mathematical Analysis (M 505) or its equivalent.
2. Adequate academic performance in at least one of following, or its equivalent:
   a. Advanced Linear Algebra M 503,
   b. Abstract Algebra (M 504).

International Students: Please refer to The Graduate School’s page International Application Process (http://www.montana.edu/gradschool/policy/admissions_intl.html) for a detailed description of additional requirements for admission including those on how to provide evidence of English proficiency.

- In order to be eligible for admission to the program, the department requires that the applicant demonstrate a minimum score on one of the following TOEFL (http://www.toefl.org/): 80-internet-based [iBT] or 550-PBT, IELTS (http://www.ielts.org/): 6.5, or PTE Academic (http://www.vue.com/pte/): 54, or Duolingo (http://englishtest.duolingo.com/): 120.

- In order to be eligible for a GTA position, the applicant must provide documentation of a minimum score of TOEFL (http://www.toefl.org/): 93-internet-based [iBT] or 550-PBT, IELTS (http://www.ielts.org/): 7.0, or PTE Academic (http://www.vue.com/pte/): 65, or Duolingo (http://englishtest.duolingo.com/): 135

It is expected that students entering the doctoral degree program are prepared to sit for at least one component of their written comprehensive exams within their first year in the program.

Typically, graduate students enter the Mathematics graduate program through the M.S. degree program; should they be interested in continuing into the Ph.D. degree program, they apply to doctoral program during their second year in the M.S. program. Typically, such an applicant is accepted provided adequate academic performance is demonstrated.

An applicant who shows promise for doctoral study but who may not yet possess the depth of understanding in analysis or algebra required to commence doctoral coursework will enter the doctoral degree program and will complete M 505, Principles of Mathematical Analysis, and M 503, Advanced Linear Algebra, in their first year of graduate study, as well as other coursework as specified by their advisor. The student will be expected to sit for a written exam addressing analysis and linear algebra prior to the second year of graduate enrollment and will be expected to pass this exam on the first or second attempt. After this written exam is completed, the student will continue to take coursework in order to prepare for the three components of the written Ph.D. comprehensive exams. In cases where it applies, this expectation will be specified in the student’s letter of acceptance.

Departmental Requirements

Described below are the Department of Mathematical Sciences requirements for the Ph.D. in Mathematics. These departmental requirements supplement those set forth by the Graduate School’s degree requirements for doctoral students (http://www.montana.edu/gradschool/policy/degreq_doctoral.html).

There are no foreign language requirements or qualifying exam for a Ph.D. in Mathematics.

Ph.D. Committee

- The Ph.D. committee must include a minimum of five members excluding the optional Graduate Representative.
- A committee must be formed before the end of the student’s third semester of study.
- The Committee Chairperson (Advisor) must be a Tenure Track faculty member within the Department of Mathematical Sciences.
- The first three committee members listed on a candidate’s Program of Study are required to read and assess the dissertation.

Course Requirements

- A minimum of 60 credit hours are required (up to 30 credits can be from a Master’s degree program).
- A minimum of 18 credit hours of Doctoral Thesis (M 690) must be taken.
- The Ph.D. student’s Program of Study listing their intended coursework must be approved by all committee members.

Typically, a Ph.D. student takes 18 credits of mathematics in courses numbered 500 or higher to prepare for their comprehensive examination. Students are encouraged to begin some form of doctoral reading or research (either informally or in the form of M 689 credits) with a committee member by their second year of study.

Mathematics Ph.D. Comprehensive Exam

The Ph.D. Comprehensive examination consists of both a written and an oral examination. The student must pass the written examination before taking the oral examination.

Written Comprehensive Exam

How a student may choose and retake exam components is determined by all of the following:

1. The written comprehensive exam consists of 4-hour exam components graded as Pass or Fail.
2. The candidate must pass three components to pass the written component of the comprehensive examination though they may attempt more.
3. If a candidate fails a component it may be attempted at most one more time.
4. The candidate must pass the following "required" component:
   a. Measure Theory (M 547) - Complex Analysis (M 551)

5. Normally the remaining components are from the following list of "standard" components. Students should choose the remaining components in consultation with their advisor. One purpose of this is to ensure sufficient breadth in the choice of tests. The student's choice must be approved by the student's Graduate Committee.
   a. General Topology (M 511) - Geometry & Algebraic Topology (M 512)
   b. Dynamical Systems I (M 595) - Dynamical Systems II (M 596)
   c. Functional Analysis I (M 584) - Functional Analysis II (M 585)
   d. Numerical Solution of Partial Differential Equations I (M 581) - Numerical Solution of Partial Differential Equations II (M 582)
   e. Partial Differential Equations I (M 544) - Partial Differential Equations II (M 545)
   f. Methods of Applied Mathematics I (M 560) - Methods of Applied Mathematics II (M 561)

6. At most one "nonstandard" component not from the "standard" components (list above) may be taken with the approval of the candidate's committee. To take such a component, a petition form must be completed.

7. Students entering the Mathematics Ph.D. program from the Mathematics M.S. program who pass both written components of the M.S. comprehensive exam at the Ph.D. level need only take two Ph.D. written comprehensive exams from the list above one of which must be the "required" component M 547 Measure Theory - M 551 Complex Analysis. Students entering the Ph.D. program from another institution may also sit for the written M.S. comprehensive exam immediately upon entrance to the Ph.D. program. If the student scores a Ph.D. level pass on both components of the exam in one attempt, then the student may use this Ph.D. level pass to satisfy one of the three written components of the written Ph.D. comprehensive exam.

8. Exams are typically given every August on dates determined by the department.

9. All students must attempt at least one exam component in the August before the beginning of their second year, and must attempt three exam components by August preceding their third year.

10. A student is permitted to take a maximum of three components each exam period. A failed component may be repeated only once and only at the discretion of the student's supervisory committee. Failure to pass the second attempt of any component of the written comprehensive exam will result in termination of graduate study and dismissal from the program.

**Oral Comprehensive Exam**

After passing the written comprehensive exam the candidate must pass an oral comprehensive exam at a date agreed upon by the candidate’s committee. This is typically within one-two years from the date of passing the written exam. Normally the oral comprehensive exam is a thesis topic proposal where the candidate's ability to conduct research on the proposal is assessed. When this is not the case, the candidate will be informed of the nature of the oral comprehensive exam by the supervisory committee. The candidate has at most two attempts to pass the oral comprehensive examination.

**Mathematics Ph.D. Dissertation Requirements**

The dissertation should embody the results of extended research by the candidate, be an original contribution to knowledge, and include new material worthy of publication. All committee members must have access to a dissertation draft at least four (4) weeks prior to the Final Defense. The dissertation must be submitted as an electronic dissertation, in final form to the Graduate School no later than 14 working days before the end of the term in which graduate work is completed.

**Mathematics Ph.D. Final Defense**

Department policies on the final defense and all other administrative procedures regarding the degree completion are exactly those as set out by The Graduate School with the exception of the following. Each member of the graduate committee must be given a **minimum of four (4) weeks** prior to the defense date to read the dissertation. The final defense is to be arranged by the major professor and the candidate. The candidate is responsible for reminding all of the committee members one (1) week in advance of the event. Examinations in which any committee member has had insufficient time to prepare should not take place and may need to be rescheduled. The graduate committee chair should discourage a candidate from defending if the candidate is not adequately prepared.