UNIVERSITY OF MONTANA

GUIDE TO GRADUATE PROGRAMS IN MATHEMATICAL SCIENCES

Department of Mathematical Sciences

The guidelines and requirements that follow apply to students entering the Department of Mathematical Sciences graduate programs

September 2022

Master's Degrees

Master of Arts (MA) Degree Requirements

The Department of Mathematical Sciences offers two options for the Master of Arts degree. Option I is the traditional mathematics option. Option II is the mathematics education option, designed to improve the proficiency of teachers in mathematics and in the techniques of teaching. Candidates for admission to the Master of Arts in Mathematics degree program should have an undergraduate mathematics major or teacher certification in mathematics. In addition to meeting the general Graduate School requirements, as set forth in the University's Graduate Bulletin, the M.A. candidate must fulfill departmental requirements as outlined below. Each student will have an advisor who must approve the individual's course of study. The department's Graduate Committee initially assigns an advisor. Students may apply to the Committee for a change of advisor.

MA 1. Course Requirements:

The Graduate School minimum course requirements for a master's degree are 30 graduate credits with a thesis or 36 graduate credits without a thesis. At least half of the credits required for a degree (excluding a combined total of 10 credits for thesis or research) will be at the 500 or 600 level. (In no case, however, will this rule require more than 18 credits of 500- or 600- level work.) To apply this rule to the course of study, subtract the number of thesis and research credits completed (up to 10 only) from the minimum number of credits required for the degree. Half of the remaining credits must be in courses at the 500 or 600 level. The student and the student's advisor design a program of studies for each student. Each year the student must complete (or update) an advisor-approved Program of Studies form which is to be kept on file in the Mathematics office. A revised form must be filed if there are any changes to the student's program during the year.

The program of studies must include one of the following mathematics content requirements. (All courses in these requirements refer to 3- or 4-credit mathematics courses.)

I. Traditional Mathematics Option.

Depth requirement: three courses in one field chosen from algebra, analysis, applied mathematics, combinatorics & optimization, statistics, and topology.

Breadth requirement: at least one course numbered greater than 400 in each of two additional fields chosen from those listed above.

Mathematics Colloquium requirement: at least one credit of Math 600 (a maximum of two credits may be applied to the degree).

Graduate Seminar requirement: two credits.

II. Mathematics Education Option.

Depth requirement: three courses in mathematics education.

Breadth requirement: four courses in mathematics from at least two areas.

Certification requirement: candidates must have a teaching certificate.

MA 2. Grades

The grades, probation and suspension policies set forth by the Graduate School apply to all graduate programs and will be followed by the math department. The math program defines making good academic progress as follows:

- taking and passing preliminary and comprehensive exams within the scheduled timeline outlined for your degree.
- following the math graduate guide policies for the number of and type of classes to be taken.

In addition to the Graduate School policies on grades, probation and suspension, the math department has its own policy on grades as follows. No grade below C (2.0) will be accepted toward any degree requirement. A student receiving a grade of C+ or lower in any mathematics course will be considered to be on probation until the student has earned 15 additional credits in his or her program. A student who receives a grade of C+ or lower in a mathematics course in any probational semester will be dropped from the program.

MA 3. Preliminary Examination:

All MA students must take and pass one preliminary exam. Students receive one of three marks on preliminary examinations; fail, pass at the master level, pass at the PhD level. An MA student must pass one Preliminary Examination at the master level or above in the depth area of their MA degree. In particular, every student earning a Master of Science in Data Science must take the Data Science exam and pass at the master level or above. The full list of possible exam topics is the same as in PhD 3. Reading lists and previous years' examinations are available to aid students studying for exams. The Preliminary Examination should not be viewed as a "final examination" for a specific course and students are expected to demonstrate insight and sophistication appropriate for graduate level work.

The examination must be passed by the beginning of the student’s fourth semester in the program. Students are strongly advised to take their examination by the beginning of their third semester in the program. In case of failure, one repeat examination is allowed. If the student fails the examination a second time he or she is recommended for dismissal. An additional oral examination may be required in unusual cases.

The Graduate Committee appoints an examining committee in each area to compose, administer and grade the preliminary exams. The preliminary examinations are given twice a year, once during the week prior to the first day of classes in the autumn and once just prior to the spring semester. Students must sign up for exams by the dates indicated by the Graduate Associate Chair at which point the exam dates will be set. Each examining committee reports the results and its recommendations to the Graduate Committee, which makes final decisions.

MA 4. MA Degree with Thesis:

When the student wishes to begin work on the Master of Arts thesis, that student must find a member of the mathematics faculty who will serve as a thesis advisor and must consult with that faculty member to determine a program of study consistent with the student's areas of interest. This program must be approved in writing by the student's academic advisor and/or the thesis advisor and kept on file in the student's academic folder in the Department secretary's files.

The thesis advisor will help the student choose a thesis topic agreeable to both parties, frequently from a number of topics suggested by the faculty member. As the thesis work proceeds, an examining committee, consisting of the advisor, and at least two other faculty members, one of who must be from another discipline is nominated by the department chair and approved by the Graduate Dean. No more than a combined total of 10 thesis and research credits (normally 6 is recommended) may be applied toward the Master's degree. Deadlines governing the submission and defense of these are listed in the University Graduate Bulletin. No final oral examination may be held without the agreement of all committee members and the Graduate Dean that the thesis is ready for defense. One copy of the final bound version of the thesis must be given to the Department of Mathematical Sciences.

MA 5. MA Degree without thesis:

Students in Option I (Traditional mathematics option) without thesis must complete at least 2 hours of research or a current literature seminar including an oral presentation of advanced-level material to a seminar or to the department. The student and the student's advisor, subject to the approval of the student's committee will make plans for the presentation, including selection of material and the decision as to how many lectures are involved. The Department Graduate Committee will certify completion of the requirement.

Students in Option II (Mathematics education option) without thesis are required, under the direction of an advisor, to prepare a professional paper and give an oral presentation on the research topic chosen.

MA 6. Completion of Degree Requirements:

The Graduate Committee will certify the completion of all degree requirements.

Doctor of Philosophy Degree

Doctor of Philosophy (Ph.D.) Degree Requirements

The Department of Mathematical Sciences offers two options for the Doctor of Philosophy degree. Option I is the traditional mathematical sciences research option. Option II is designed specifically to give students a broad background and to educate them to be college teachers. The Graduate Committee initially assigns each Ph.D. student an advisor. The student may apply to the Graduate Committee for a change of advisor. In addition to abiding by the rules and regulations set forth in the University Graduate Bulletin, all students must fulfill departmental requirements as outlined below.

PhD 1. Course Requirements (Options I and II):

Each student must complete a program of graduate course work designed to give the student breadth and depth appropriate to the chosen option. Each student must present at least 60 credits for the Ph.D. degree. No more than a combined total of 21 dissertation and research credits may be applied toward the PhD degree. It is desired that the student have as great a choice in designing the curriculum as possible, but a student must consult with his/her advisor about the program. Each year the student must complete (or update) an advisor-approved Program of Studies form which is to be kept on file in the Mathematics office. A revised form must be filed if there are any changes to the student's program during

the year. The thesis advisor, the Graduate Committee, or the preliminary examination committee may specify certain courses the student must take to rectify identified deficiencies.

The program of studies must include the following:

a) Breadth requirement - Option I: at least three three-credit courses, numbered 400 or above, in each of two fields chosen from algebra, analysis, applied mathematics, combinatorics & optimization, statistics, and two three-credit courses, numbered 400 or above, in an additional two fields chosen from algebra, analysis, applied mathematics, combinatorics & optimization, statistics, topology or a field chosen with an advisor.

   Breadth requirement - Option II: at least three three-credit courses, numbered 400 or above, in each of two fields chosen from algebra, analysis, applied mathematics, combinatorics & optimization, mathematics education, statistics, and two three-credit courses, numbered 400 or above, in an additional two fields chosen from algebra, analysis, applied mathematics, combinatorics & optimization, mathematics education, statistics, topology or a field chosen with an advisor.

   Students with computer science as their specialization can choose one of their fields to be computer science, and must take (or have taken as part of a previous Master's degree) at least 30 credits in mathematics or statistics approved by the Department of Mathematical Sciences. At least 15 of these credits must be taken in the Department of Mathematical Sciences at the University of Montana; at least 9 of these 15 credits must be at the 500 or 600 level.

b) Depth requirement: to be determined by the student and the advisor as necessary for dissertation work in the student's chosen area.

c) Mathematics Colloquium: one credit.

d) Graduate Seminar Requirement: 2 credits (taken in the first two years of program)

e) In addition, Option II students must

   1. Take at least two courses in a fourth field listed in part a.
   2. Take M 602 Teaching College Mathematics
   3. Have one semester of teaching internship, with at least one semester of preparation prior to the internship. When a graduate student serves an internship with a faculty member, the course will still count in full towards the faculty member's teaching load. When the student is a teaching assistant, the Chair in consultation with the advisor and the student will determine the teaching load of the TA.
   4. Complete a current topics project that requires the student to present an expository talk in the Mathematics Colloquium series. The subject of the talk, to be agreed upon by the student and his/her advisor, should be based on reading in the current mathematics literature, or on a study of mathematical history, or on the student's experiences in an applied analysis consulting

project. Note that this colloquium talk is in *addition* to a colloquium talk on the student's dissertation as required in PhD 8.

PhD 2. Grades

The grades, probation and suspension policies set forth by the Graduate School apply to all graduate programs and will be followed by the math department. The math program defines making good academic progress as follows:

- taking and passing preliminary and comprehensive exams within the scheduled timeline outlined for your degree.
- following the math graduate guide policies for the number of and type of classes to be taken.

In addition to the Graduate School policies on grades, probation and suspension, the math department has its own policy on grades as follows. No grade below C (2.0) will be accepted toward any degree requirement. A student receiving a grade of C+ or lower in any mathematics course will be considered to be on probation until the student has earned 15 additional credits in his or her program. A student who receives a grade of C+ or lower in a mathematics course in any probational semester will be dropped from the program.

PhD 3. Preliminary Examinations (Options I and II)

All PhD students must take and pass two preliminary exams. Students receive one of three marks on preliminary exams; fail, pass at the MA level, pass at the PhD level. PhD students must pass two distinct preliminary examinations at the PhD level in areas chosen from algebra, analysis, applied math, combinatorics & optimization, data science and statistics with at most one PhD pass coming from data science or statistics. Students with mathematics education as a specialization can choose to write one of their preliminary examinations in mathematics education. Students with computer science as their specialization can choose to write one of their preliminary examinations in computer science.

Reading lists and previous years' examinations are available to aid students studying for exams. A test should not be viewed as a "final examination" for a specific course; and students are expected to demonstrate insight and sophistication appropriate for doctoral level work.

The Graduate Committee appoints an examining committee in each area to compose, administer and grade the preliminary exams. The preliminary examinations are given twice a year, once during the week prior to the first day of classes in the autumn and once just prior to the spring semester. Students must sign up for exams by the dates indicated by the Graduate Associate Chair at which point the exam dates will be set. Each examining committee reports the results and its recommendations to the Graduate Committee, which makes final decisions.

For a student admitted to the PhD program with a Master's degree in the mathematical sciences, one examination must be passed by the beginning of the student's third semester in the program and the examination in a second area must be passed by the beginning of the student's fourth semester in the program. Students are strongly advised to take their examinations by the beginning of their second and third semester in the program

respectively. Students who completed their MA degree in the department before entering the Ph.D. program may count all PhD level passes received on preliminary exams while in the MA program toward this requirement.

For a student admitted to the PhD program without a Master's degree in the mathematical sciences, one examination must be passed by the beginning of the student's fourth semester in the program and the examination in a second area must be passed by the beginning of the student's fifth semester in the program. Students are strongly advised to take their examinations by the beginning of their third and fourth semester in the program respectively.

PhD 4. Computer Recommendation

There is no explicitly required knowledge of a computer language, but it is recommended that each student have knowledge of at least one scientific language.

PhD 5. Comprehensive Examination (Options I and II)

Upon completion of the preliminary examinations, the candidate and the advisor, with the approval of the Graduate Dean, will select at least three additional members of the mathematics faculty and a faculty member from a cognate field whose duty will be to administer a comprehensive examination. For a student whose specialization is computer science, the Computer Science department chair will also participate in the choice of this committee, computer science faculty will be considered to be from the unit granting the degree, and at least two members of the Dissertation Committee must be from the Department of Mathematical Sciences. Students should take this examination no later than their third year in the program. The comprehensive examination will be written and will be designed by the committee members. A syllabus of the topics to be covered on the examination will be prepared by the Committee in a meeting in consultation with the student. The purpose of the examination is to determine whether or not the student may successfully be able to write a dissertation in a chosen area. The examination emphasizes, but is not restricted to, the area of specialization of the student. The specific areas and form of the examination are to be determined by the examining committee. The Graduate Committee must approve the syllabus and form of the examination at least one month prior to the examination being given. The comprehensive examination may be repeated only once and the repeat must be with the same comprehensive examination committee following the guidelines in the University Graduate Bulletin. The examining committee will meet within two weeks of the completion of the exam to decide the outcome of the exam. All voting follows the rules set forth in The University of Montana Graduate School Bulletin.

PhD 6. Advance to Candidacy (Options I and II)

A student is "advanced to candidacy" when requirements PhD2-5 are met.

PhD 7. Dissertation (Options I and II)

Once an advisor accepts a student as a dissertation advisee, the student and advisor form a dissertation committee consisting of five people, following the rules in the grad school policy D4.100. The dissertation committee, when appointed, must include at least three tenure-track members of the department of mathematical sciences. For a student whose specialization is computer science, the Computer Science department chair will also

participate in the choice of this committee, computer science faculty will be considered to be from the unit granting the degree, and at least two members of the Dissertation Committee must be from the Department of Mathematical Sciences. The Graduate Dean prior to the submission of a dissertation proposal must approve this committee.

a) An Option I dissertation must constitute a creative contribution to the research literature in a specialized field of mathematical sciences in accord with the standards of the profession.

b) An Option II dissertation must constitute an original contribution to the scholarship of the mathematical sciences. Option II allows more breadth and the student might undertake to survey a developing mathematical science discipline by bringing together work scattered through the literature, and reworking and synthesizing this literature. The student might undertake a historical study or might present the mathematical side of a cooperative multidisciplinary subject. In the Option II mathematics education dissertation, the student might consider pedagogical matters or development of mathematical curricula.

PhD 8. Colloquium Talk on the Dissertation (Options I and II)

At an appropriate point in the dissertation work to be decided upon by the student and the advisor, the student shall give an expository talk in a mathematics colloquium in the general area of the dissertation topic.

PhD 9. Oral Defense of the Dissertation (Options I and II)

When a draft of the dissertation that is substantially acceptable to the student's dissertation committee and Graduate Dean exists, the student is allowed to stand in oral defense of the dissertation. The dissertation must be submitted to the graduate Dean at least one week before the date of the final examination. Members of the dissertation committee should get a copy of the dissertation at least one month prior to the scheduled defense, and a copy of the dissertation must be available in the Mathematics Office for public inspection at least two weeks prior to the scheduled defense. A PhD dissertation defense can take place only during the autumn and spring semesters; variances must be approved by the Graduate Committee. The PhD dissertation defense has to be announced at least three weeks prior to the scheduled defense. The announcement will contain title and synopsis (abstract) of the dissertation. The defense is normally two hours in length. The first part (hour) of the dissertation defense is open to the public and consists of a synopsis of the dissertation followed by questioning from the floor (anyone may ask questions on recognition by the chair of the dissertation committee). Following this public part of the defense, the second part of the defense is open to faculty members (not only the dissertation committee, but every faculty member interested to stay may do so) and representatives from the Graduate School. Only the dissertation committee, meeting privately following the defense, may vote on acceptance or non-acceptance of the dissertation. The dissertation committee may require further defense if serious flaws in the thesis are discovered during the defense or in subsequent drafts of the dissertation. Voting for acceptance or non-acceptance is according to The University of Montana Graduate Bulletin. According to Graduate School Policy D5.200 this means:

D5.201 The student will pass if the dissertation is accepted (either as it stands or pending minor revisions) with only one negative vote.

D5.202 If there are two or more negative votes, the committee may schedule and conduct a second and final examination at least one month after the initial defense. During that time, the student will be asked to make whatever changes are necessary in the dissertation.

PhD 10. Completion of Degree Requirements:

The Graduate Committee will certify the completion of all degree requirements. A graduation checklist *must* be approved by the Graduate Committee prior to the beginning of the semester in which a student is to graduate.

Departmental Governance of Graduate Matters

The Graduate Committee of the Department of Mathematical Sciences is in charge of overseeing the Department's graduate programs. The duties of the committee include, but may not be limited to, recruitment; handling application and admissions to the program; graduate mathematics matters, including examinations; and making teaching assistantship recommendations.

The Department of Mathematical Sciences recognizes the need for continuous communication between faculty members and graduate students. To emphasize open communications, all students are welcome to attend any Graduate Committee meeting where individual students are not being discussed.

Informal communication between students and faculty members is encouraged, but formal communications are sometimes necessary among the Graduate Committee, Department Chair, and graduate students. Such formal communications may involve academic problems or teaching assistantship problems. Matters of an academic nature will normally be handled by the Graduate Committee, but may involve communications with the student, a representative chosen by the student (if one is desired), the student's advisor and/or committee.

Matters involving teaching assistantship problems will typically be handled by the Course Coordinator, and the Department Associate Chair or Chair. If necessary, discussions among the student, a representative chosen by the student (if one is desired), the appropriate Course Coordinator, the Chair or Associate Chair, and the Dean of the College of Arts and Sciences may be organized to address the problem(s).

Student Progress and Financial Support

Financial support is available in the form of teaching assistantships (TA), research assistantships (RA), pre-doctoral associates (PDA), or graduate student instructorships (GSI). Continued financial support depends on satisfactory progress toward a degree. Normally 2 years of support are allowed for a student in the MA program, 4 years for a student with an MA working toward the PhD, and 5 years for a student who begins in the PhD program without an MA degree.

All graduate students with financial support are expected to make satisfactory progress in a degree program. Master's students must take two scheduled courses* in mathematics or an approved cognate every semester. Doctoral students must take two scheduled courses* in mathematics or an approved cognate every semester until the Comprehensive Examination is passed. After the Comprehensive Exam, a doctoral student's load may be reduced to taking only one scheduled course* in mathematics or an approved cognate per semester if the advisor agrees that there is satisfactory progress in research and thesis. A one-time exemption to allow a student to work full time on the dissertation for one semester may be requested.

*scheduled courses are regularly-scheduled courses, which can include experimental courses but not independent study courses or seminars.

Leave of Absence

The Graduate School may grant a Leave of Absence (LOA) for a maximum of one calendar year if a completed form is submitted, signed by the student and appropriate departmental program representatives. The request must be accompanied by a program summary outlining what portions of the degree program have been completed, what requirements remain and a schedule for resumption of graduate study. The Graduate School upon receipt of a written request may grant a 12-month extension to a LOA from the student and concurrence from the affected program.

Time Limits

With the exception of programs within the School of Education, students pursuing a master's degree must complete all required program elements within five (5) years of commencing graduate course work at The University of Montana. Students engaged in doctoral programs must complete all required program elements within seven (7) years of commencing graduate course work at The University of Montana.