Mathematics and Statistics, University of New Mexico

Graduate Handbook for Mathematics

SMLC, University of New Mexico, Albuquerque, NM

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Contents

1 Overview

This handbook describes the Department's rules governing graduate study and the awarding of degrees in Mathematics. The Department also awards graduate degrees in Statistics, but this handbook is dedicated to degrees in Mathematics. To download the *Graduate Handbook for Statistics*, see `http://www.math.unm.edu/graduate/graduate-studies-statistics`. To address questions not covered here, students should either consult with faculty or refer to the University of New Mexico (UNM) Catalog; see `http://registrar.unm.edu/UNM%20Catalog/index.html`. Should conflicts arise between statements found in this handbook and the UNM Catalog, the latter takes precedence. The rest of this overview collects relevant information and summarizes our degree programs. Subsequent sections describe degree requirements.

1.1 Acronyms

MS (Master of Science)	PhD (Doctorate of Philosophy)	TA (Teaching Assistant)
RA (Research Assistant)	FA (Faculty Advisor)	PS (Program Specialist)
GS (Office of Graduate Studies)	POS (Program of Studies)	QE (Qualifying Exam)

1.2 Contact

Mailing address:

Graduate Studies Committee
Department of Mathematics and Statistics
MSC01 1115, University of New Mexico
Albuquerque, NM 87131-1141

Main office phone: (505)277-4613
Website: `http://www.math.unm.edu`

1.3 Graduate degrees awarded

The Department awards Master of Science (MS) and Doctor of Philosophy (PhD) degrees in Mathematics. The degree concentration can be either Pure Mathematics or Applied Mathematics.

The MS in Mathematics is awarded under either Plan I (26 hours with 6 hours of thesis) or Plan II (32 hours). Instead of writing a thesis, Plan II students must pass the MS/PhD Qualifying Exams (QEs) at the Master's level. To enter the PhD program, students must pass this same exams but at a higher level; hence the PhD examination requirements are the same as those listed for MS Plan II. After passing the MS/PhD QEs, a PhD candidate must fulfill 18 additional hours of course credits, pass the Doctoral Comprehensive Exam, fulfill a language requirement, accumulate at least 18 hours of dissertation credits, and submit and defend a dissertation.

General requirements for both MS and PhD Mathematics degrees are found in the online UNM Catalog; see `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`. This handbook describes specific requirements, necessary paperwork, and deadlines.

1.4 Application deadlines

To be considered for the Fall Semester, your application must be received by the Office of Graduate Studies (GS) by 30 April, and by 15 February should you also seek financial assistance. The GS website is `http://grad.unm.edu/home/index.html`. To be considered for the Spring Semester, your application must be received by 1 November. Those seeking Teaching Assistantships (TAships) are encouraged to apply as early as possible.

1.5 Financial aid

The Department awards a number of TAships and a limited number of Research Assistantships (RAships) each year. Most TAships are awarded mid-semester in the spring to applicants who then begin their duties in the fall. Individuals seeking TAships are encouraged to apply early. GS administers all assistantships. For more information see the section *Financial Assistance and Support Programs* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`. RAships are typically awarded to graduate students embarking on a research program with their Faculty Advisor (FA).

Furthermore, UNM has a variety of financial support programs and fellowships, several for underrepresented groups. Information on additional sources of financial support is available from GS (505)277-2711 or the Financial Aid Office (505)277-8900; see also `http://financialaid.unm.edu/`.

1.6 Selection criteria for Teaching Assistantships

The Graduate Committee both awards TAships and decides which graduate students should be retained as TAs. The following criteria are used in evaluating applicants for TAships.

- Undergraduate major; typically it should be in Mathematics, Statistics, or a related scientific field.

- Undergraduate grade point average, with particular emphasis on Mathematics and Statistics courses.
- Letters of recommendation.
- Potential for academic achievement at the graduate level.
- Potential for teaching beginning courses in Mathematics and Statistics.
- Desire to participate in and contribute to a culturally diverse academic environment.
- English proficiency (for foreign applicants only). Please see `http://geo.unm.edu/admission/graduate/requirements/eng_language.html`.

1.7 Advising

New graduate students in the Department should report to both the Graduate Chair and the Department Program Specialist (PS). Students will be assigned a Faculty Advisor (FA) by the Graduate Chair. Each semester the FA must approve the student's Program of Studies (POS). It is the student's responsibility to obtain the FA-approved POS and return it to the PS. Students who fail to obtain their FA's approval for their POS may be subject to dismissal from the program. A student can change advisors by contacting the Graduate Chair or the PS.

2 Master's degree

2.1 General requirements

The Master of Science (MS) degree is awarded through one of two plans: Plan I (thesis option) and Plan II (non-thesis option). In addition to the general requirements for Plans I and II, the Department also imposes requirements specific to the options of Pure or Applied Mathematics. While a student may choose a minor field of study in consultation with their FA, there is no formal minor requirement for the Master's degree in Mathematics.

2.2 Plan I

- A minimum of 26 hours of coursework at the 400 or 500 level in Mathematics and Statistics and related fields. 400 level courses must be taken for graduate credit, although neither Math 401/501 nor 402/502 may be counted. At least 20 of these hours must be within the Department; of these at least 12 hours must be 500 level.
- At least 50 percent of course requirements must be completed after admission to the graduate program. The Department will accept up to 12 hours of non-degree credits in Mathematics.
- A maximum of 6 hours in "problems" or "individual study" courses.
- At least 6 hours of thesis credit. Additional hours of thesis credit will not count towards the minimum 26 hours of coursework required under Plan I.
- A Final Examination, the defense of the Master's thesis. This defense is in lieu of the MS/PhD QEs required under Plan II.

2.3 Plan II

- A minimum of 32 hours of coursework at the 400 or 500 level in Mathematics and Statistics and related fields. 400 level courses must be taken for graduate credit, although neither Math 401/501 nor 402/502 may be counted. At least 26 of these hours must be within the Department; of these at least 12 hours must be 500 level.
- At least 50 percent of course requirements must be completed after admission to the graduate program. The Department will accept up to 12 hours of non-degree credits in Mathematics.
- A maximum of 12 hours in "problems" or "individual study" courses.
- Master's level passes on the MS/PhD QEs.

A Program of Studies (POS) for the Master's degree must be filed with the Dean of Graduate Studies during the semester before the student plans to take the Master's exam under Plan II, or defend the Master's thesis under Plan I. See `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`under the heading *Program of Studies (Master's Degrees and Transcripted Certificates)*. The form for the POS may be found under the heading *Academics* at `http://grad.unm.edu/resources/gs-forms/index.html`.

2.4 Area requirements

The area concentration of the Master's degree may be either Pure or Applied Mathematics. Specific requirements for both options are given below.

2.4.1 Pure Mathematics: admission requirements

Admission requires a bachelor's degree in Mathematics or a related field. Undergraduate work should include (the equivalent of) at least semester-length courses in linear algebra, abstract algebra, and advanced calculus.

2.4.2 Pure Mathematics: course requirements

As listed above, Plan I requires a minimum of 26 hours of graduate course work plus 6 hours of thesis, while Plan II requires a minimum of 32 hours of graduate course work. Under either plan up to 6 of these graduate-level hours may be taken outside the Department. Under both plans the coursework concentration is Mathematics and must be approved by the student's FA. Under both plans completion of the following courses (or their equivalent in transfer credit) is required.

- Math 510, Introduction to Analysis I
- Math 520, Abstract Algebra I
- Math 535, Foundations of Topology
- Math 561, Functions of a Complex Variable I

Credit must also be earned in at least two of the following courses.

- Math 511, Introduction to Analysis II

- Math 521, Abstract Algebra II
- Math 536, Introduction to Differentiable Manifolds
- Math 562, Functions of a Complex Variable II

Their completion is recommended; nonetheless, substitutions for these courses may be made, but any substitution requires approval of both the student's FA and the Graduate Committee.

2.4.3 Pure Mathematics: examination requirements

The Master's Examination for Plan I students is the defense of a Master's thesis. A Master's degree under the Plan I option is considered a terminal degree, and a student has two attempts to pass the Master's Examination. The Master's (Written) Examination for Plan II is the set of MS/PhD QEs, and students have two attempts to pass these exams. A PhD level pass of these exams requires a higher standard of performance.

The MS/PhD QEs for the Pure Mathematics concentration consist of any three of the following four topics:

- Real Analysis
- Complex Analysis
- Abstract Algebra
- Topology and Geometry

The course sequences Math 510-511 (Real Analysis), Math 561-562 (Complex Analysis), Math 520-521 (Abstract Algebra), and Math 535-536 (Topology/Geometry) provide a foundation for the material covered by the examinations. Syllabi, references, and previous exams from the Department's website `http://www.math.unm.edu`. In particular, see the heading Graduate/Past Qualifying Exams.

A student awarded a Master's degree under Plan I and wishing to pursue the PhD degree must pass the MS/PhD QEs.

2.4.4 Applied Mathematics: admission requirements

Applicants should have a bachelor's degree in Mathematics or a related area. Courses that provide a good background for the program are advanced calculus, introductory ordinary and partial differential equations, linear algebra, complex variables, probability theory, and an introduction to scientific computing.

2.4.5 Applied Mathematics: course requirements

As listed above, Plan I requires a minimum of 26 hours of graduate course work plus 6 hours of thesis, while Plan II requires a minimum of 32 hours of graduate course work. Under either plan up to 6 of these graduate-level hours may be taken outside the Department. Under both plans the coursework concentration is in Mathematics and scientific applications, and it must be approved by the student's FA. Under both plans completion of the following courses (or their equivalent in transfer credit) is required.

- Math 512 and Math 513, Differential Equations
- Math 514 and Math 504, Numerical Analysis
- Math 561, Complex Analysis

Plan II students should also complete the following recommended courses (or their equivalent in transfer credit).

- Math 505, Numerical Analysis
- Math 510, Introduction to Analysis
- Math 583, Methods of Applied Mathematics I

While their completion is recommended, substitutions for these courses may be made, but any substitution requires approval of both the student's FA and the Graduate Committee.

2.4.6 Applied Mathematics: examination requirements

The Master's Examination for Plan I students is the defense of a Master's thesis. A Master's degree under the Plan I option is considered a terminal degree, and a student has two attempts to pass the Master's Examination. The Master's (Written) Examination for Plan II is the set of MS/PhD QEs, and students have two attempts to pass these exams. A PhD level pass of these exams requires a higher standard of performance.

The MS/PhD QEs for the Applied Mathematics concentration consist of any three of the following four topics:

- Differential Equations
- Real Analysis
- Numerical Analysis
- Complex Analysis

The course sequences Math 512-513, Math 514-504, Math 510-511, and Math 561-562 provide a foundation for the material covered by the examinations. Syllabi, references, and previous exams from the Department's website `http://www.math.unm.edu`. In particular, see the heading Graduate/Past Qualifying Exams.

A student awarded a Master's degree under Plan I and wishing to pursue the PhD degree must pass the MS/PhD QEs.

2.5 Application for candidacy

After 15 to 18 hours of resident graduate credit, students request the POS form from the Department PS. In consultation with the student's FA, the candidate lists completed and projected course work and declares either Plan I (thesis) or Plan II (non-thesis). The application form is then returned to the PS for signatures by the FA and Department Chair. It is then sent to GS for the approval by the Dean of Graduate Studies.

2.6 Master's Thesis (Plan I)

2.6.1 Committee

Students pursuing the MS under Plan I need to form a Thesis Committee overseeing their progress and examination. As an MS Plan I student, you should consult with your FA about serving as chair of the Thesis Committee. Additionally, you need to obtain the consent of two other faculty to serve as members of the committee. For the University's policies regarding the Master's Thesis Committee, see `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`under the heading *Committee Compositions* and sub-heading *Master's Exam and/or Thesis Committees*.

2.6.2 Credit hours

Students opting for the MS with thesis must complete a minimum of 6 hours of Thesis (599) credit. While working on the thesis, students must continue to register for a minimum of one hour of 599 each Fall and Spring Semester until the Dean of GS approves the thesis. Thesis candidates must be enrolled the semester in which they complete degree requirements, including summer sessions.

2.6.3 Defense and submission

At least two weeks prior to the Thesis Defense (and no later than November 1 for Fall, April 1 for Spring, and July 1 for Summer), the Department must submit the announcement form notifying GS of the scheduled defense date for the Master's Thesis. The form is filled out by the student and then given to the Department PS for completion and submission to GS. The intention to defend should be made to the PS at least three weeks prior to the defense so that the appropriate forms are submitted in a timely manner to GS. Guidelines for electronic submission of the thesis to LoboVault may be found at `http://grad.unm.edu/degree-completion/thesis-dissertations/lobovault.html`.

2.7 Written Examination (MS Plan II and PhD Qualification)

As mentioned the Examination for the MS Plan II is the set of MS/PhD QEs; these are given in the subjects Algebra, Real Analysis, Complex Analysis, Geometry/Topology, Differential Equations, and Numerical Analysis. The exam in each subject is based on a fixed syllabus posted on the Department's website. Responsibility for the topics listed on the exam syllabus rests with the student, regardless of whether recent sections of the corresponding course have covered the material. Likewise, faculty writing an exam should choose problems with regard to the official syllabus, regardless of whether a section of the course has covered a particular off-syllabus topic. Students should review the relevant syllabi well in advance of the exams. The MS/PhD QEs consist of the same problems. Passing grades differ according to level; a lower grade suffices to pass at the Master's level than at the PhD level.

The MS/PhD QEs are administered twice a year, just prior to the start of the Fall and Spring Semesters. Exact dates are announced by the Department PS in an email. Upon announcement, and no later than three weeks prior to their administration, a student intent

on taking one or more exams must, with their FA's approval, inform the Department PS of their intent by email.

2.7.1 Preliminary attempts

Full-time graduate students enrolled in the Master's program under Plan II (and those aiming to qualify for the PhD program) may attempt the MS/PhD QEs without formal consequences prior to the second semester of their graduate career. The purpose of these preliminary attempts is to assess the student's initial progress. A preliminary attempt does not count as one of the student's two attempts to pass a particular MS/PhD QE. Nonetheless, a student who obtains an MS or PhD pass on the exam earns a waiver for it. For other students, based on the outcome of any preliminary attempts, the content their MS/PhD QEs will consist of 1 to 3 exams.

2.7.2 Deadline for completion

Prior to the fifth semester of full-time graduate study, a student enrolled in the Master's program under Plan II (or aiming to qualify for the PhD program) must have successfully completed the MS/PhD QEs.

Each student has a maximum of 2 consecutive tries to pass each exam at the relevant level. Preliminary exams are not counted as one of the tries. A second attempt at one of the exams must occur within one semester from the first attempt. Students attempting to qualify for the PhD program may still graduate with an MS provided they have passed each exam at the MS level or higher.

A student who, having exhausted all tries, has still not passed all exams at the required level is typically disenrolled from the program. Through appeal to the Graduate Committee, a student in this situation may nevertheless be allowed to continue; however, such appeals are only approved under special circumstances.

> *The Graduate Committee typically requires teaching and research assistants to complete the MS/PhD QEs before the beginning of the fifth semester of the graduate program as a condition of continued support.*

Students may request a delay in their MS/PhD QEs. The Department Graduate Committee must approve such requests, with approval granted only under special circumstances.

Faculty view the MS/PhD QEs as an indicator of a graduate student's ability to write a PhD dissertation. The rules governing these exams are therefore stringent. They especially pertain to graduate students who receive TA or RA funding through the Department.

2.7.3 Part-time and transfer students

Part-time students must develop a reasonable timetable for completing their exams. Timetables need approval by the FA and the Graduate Committee.

Students transferring from other graduate programs may request a waiver for exams they have passed elsewhere. However, the Graduate Committee will approve such requests only if the student proves that (i) the level of the passed exam is at, or exceeds, the level of the corresponding UNM exam and (ii) the passing grade was outstanding.

3 Doctoral degree

A student in the PhD program aims to write a dissertation which makes a contribution to Mathematics. To achieve this end, the student must first become familiar with the breadth of a current research topic. Such familiarity stems from advanced courses, research seminars, colloquia, scholarly literature, and discussions with faculty. Colloquia attendance is particularly worthwhile; active researchers from around the world give Department colloquia on their current research. Students should read each faculty member's research description, following up on points of interest by asking faculty for reading material.

3.1 Admission to the program

Students already admitted to graduate study in Mathematics or Statistics enter the PhD program by passing the PhD Qualifying Examination. The PhD Qualifying Examination is the set of MS/PhD QEs described earlier. Therefore, for UNM students who are candidates for the Master's degree, the Master's Written Examination and PhD Qualifying Examination are the same, and the requirements for both have been listed in Subsection 2.7 on the Master's degree. As noted there, prospective PhD students must demonstrate that they have more fully mastered the exam material.

For students who transfer to UNM with a Master's degree from another institution, it is required that they take the PhD Qualifying Examination as soon as practical, and no later than one year after admission. Students who have passed a qualifying exam in Mathematics or Statistics at another institution may petition the Graduate Committee for an exemption from the qualifying exam requirement. Each student who passes the PhD Qualifying Examination should arrange for the appointment of a Committee on Studies. This is done in consultation with the Graduate Committee and as soon as possible after satisfying the qualifying exam. The chairperson of the committee on studies becomes the student's FA.

3.2 General requirements

The first phase of the doctoral program is a minimum of 18 semester hours of coursework in Mathematics and Statistics beyond the Master's degree. Not more than 6 of these hours may be taken in reading or special topics courses. Proficiency in a language other than English must also be demonstrated (see Subsection 3.6 for details). Once these requirements are satisfied, the student takes the PhD Comprehensive Examination. In Mathematics this is usually an oral examination. The purpose of the examination is to test the student's foundation in the area in which dissertation work is to be undertaken. Upon passing the PhD Comprehensive Examination, the student is formally advanced to doctoral candidacy and may then begin work on a dissertation. Upon completion of the dissertation and at least 18 hours of dissertation course work, a final examination, i.e. defense of the dissertation, is the last formal step before the PhD is awarded.

3.3 Area requirements

3.3.1 Pure Mathematics

The POS in Pure Mathematics —designed by the student and the Committee on Studies— depends on the research interests of the student. Current areas of research in Mathematics in the Department include: differential geometry and global analysis, algebraic geometry, number theory, commutative algebra, harmonic analysis, and operator theory. We have experts in these areas with worldwide recognition for their research. Students in the Pure Mathematics PhD program are expected to know the course material required for the MS program. In addition to the MS course requirements, students must complete at least two one-year sequences of advanced courses, or their equivalents in transfer credit, chosen from the following sequences.

- Math 530 and Math 531 (Algebraic Geometry I and II)
- Math 532 and Math 533 (Algebraic Topology I and II)
- Math 537 and Math 538 (Riemannian Geometry I and II)
- Math 563 (Measure Theory) and Math 581 (Functional Analysis)
- Math 572 (Fourier Analysis and Wavelets) and Math 565 (Harmonic Analysis)

Students should also make a habit of attending research seminars and colloquia; *credit for attendance in at least four Department seminars is required.*

3.3.2 Applied Mathematics

The POS in Applied Mathematics —designed by the student and the Committee on Studies— depends on the research interests of the student. The POS is flexible and encourages interdisciplinary interaction with other departments; current areas with interdisciplinary interaction include scientific computing, fluid and solid mechanics, mathematical biology, mathematical physics, non-linear optics, dynamical systems, and material science. Students in the Applied Mathematics PhD program are expected to know the course material required for the MS program. In addition to the MS course requirements, the POS for the PhD in Applied Mathematics requires the following courses, or their equivalents in transfer credit.

- Math 505, Numerical Analysis
- Math 510, Introduction to Analysis
- Math 583, Methods of Applied Mathematics I
- Math 584, Methods of Applied Mathematics II

Students should also make a habit of attending research seminars and colloquia; *credit for attendance in at least four Department seminars is required.*

3.4 Application for PhD candidacy

After 18-21 hours of doctoral coursework and with PhD passes on the MS/PhD QEs, students obtain the *Application for Candidacy for the Doctoral or MFA Degree* form (found at `http://grad.unm.edu/resources/gs-forms/index.html` under the heading *Academics*) and return it in to the Department PS. In consultation with the student's Committee Chair

on Studies, the candidate lists completed and projected coursework. At this time, the student also formally declares a Committee on Studies. The application must be signed by the entire Committee on Studies and then returned to the PS, whereupon it is signed by the Department Chair and forwarded to GS for approval. This procedure roughly coincides with the timing of the student's Comprehensive Exam.

3.5 Committee on Studies

Each doctoral student must have a Committee on Studies, which eventually becomes the core of the Dissertation Committee. The committee should be chosen immediately after passing the MS/PhD QEs at the PhD level. The Committee should consist of a minimum of three faculty members; at least two must be from the Mathematics faculty. Each member should be appropriate for the student's interest (i.e. the Committtee Chair and one other member must be from the student's option; one member may be from outside the Department). All members must be tenured or tenure-track faculty at an accredited institution.

At the time of candidacy approval, the Committee composition requires final approval from the Graduate School Dean. With this approval it becomes the Dissertation Committee. The Dissertation Committee must also include one member from outside the Department, if the Committee on Studies does not include one already. The *Appointment of Dissertation Committee* form is found at `http://grad.unm.edu/resources/gs-forms/index.html` under the heading *Examination/Grades*.

The chair and/or members of the PhD Committee on Studies may be changed whenever the student desires. However, the student will need the consent of faculty being added to the committee, and must notify both former and new members of the Committee and the Department PS of changes.

The Committee and the student work out the student's PhD program, usually during the first semester of enrollment. More specifically, the functions of the Committee on Studies include the following.

- Meet with the student at necessary intervals.
- Establish prerequisites and review deficiencies.
- Plan with the student: approve and direct an integrated program including work in necessary supporting fields, if any.
- Recommend transfer of credit.
- Approve the Application for Candidacy.
- Determine the individual doctoral requirement in foreign languages and/or other technical skills.
- Act as the Doctoral Comprehensive Examination Committee.
- Recommend that the student shall or shall not be advanced to Candidacy.

3.6 Language requirement

Each doctoral student in Pure or Applied Mathematics is expected to attain proficiency in one foreign language, chosen from French, German, or Russian. Substitution of another language is possible through a petition to the Committee on Studies by the student. In

the special circumstance that foreign language proficiency is thought to be unnecessary in the student's research area, the Graduate Committee may be petitioned to substitute another requirement relevant to the research area. The language requirement for an accepted language may be satisfied by one of the following.

- Completion of three semesters as an undergraduate with at least a C average, with a grade of C or better during the third semester.
- Completion of MCL 365, 366 "Language Reading for Graduate Students" with a grade of B or better in both courses.
- A passing mark on a standard examination, such as the ETS.
- A passing mark on a Departmental language examination.

The following form is used to certify completion of the language requirement: `http://grad.unm.edu/resources/gs-forms/documents/language-skills.pdf`.

3.7 Comprehensive Examination

This is usually an oral examination conducted by the Committee on Studies. The examination's purpose is to test the student's foundation in the area in which dissertation work is to be undertaken. For details please see the heading *Doctoral Comprehensive Examination* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`. Students are expected to pass their Comprehensive Examination within 3 to 4 semesters after passing the MS/PhD QEs at the PhD level.

3.8 Dissertation

3.8.1 Committee

Doctoral students formally constitute a Dissertation Committee after passing the Doctoral Comprehensive Examination. This committee's core is typically, but does not have to be, the same as the Committee on Studies. Students initiate formation of their committee by selecting a faculty member to serve as director of the dissertation and chair of the committee. These two then agree upon the remainder of the committee and complete an *Appointment of Dissertation Committee* (see above). This form requires the signature of the candidate and the Dissertation Committee Chair. It is then turned into the Departmental PS for signatures from the Department Chair and the Dean of GS.

The Dissertation Committee must include at least four members approved for graduate instruction by the Dean of Graduate Studies. At least two members must hold regular full-time appointments at UNM, and one member must hold a regular appointment outside the student's department. This member may be from UNM or another accredited institution. No more than one of the committee members may be a non-faculty expert in the student's major area. See the heading *Dissertation Committee* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`.

3.8.2 Credit hours

The program for the doctorate includes a minimum of 18 hours of dissertation (699) credit, see Section 3.3 in this handbook for details. While working on the dissertation, students must continue to register for at least three hours of 699 each Fall and Spring Semester until the Dean of GS approves the dissertation. Doctoral candidates must be enrolled the semester in which they complete degree requirements, even if this semester is a summer session. Enrollment in 699 dissertation hours may not begin prior to the semester in which Comprehensive Examination is taken. The cost of dissertation hours is the same for 3 to 18 hours. Check current tuition rates for dissertation hours rates.

3.8.3 Progress

Once the dissertation proposal has been approved, the Dissertation Committee handles all subsequent matters related to the completion of requirements for the Ph.D. The Chair of the Dissertation Committee, together with other members, will be responsible for directing and advising the dissertation research, overseeing the writing, evaluating and approving the completed dissertation, and presiding over the defense.

3.8.4 Final defense and submission

In a oral presentation each candidate must defend their dissertation, describing its contribution to the relevant field of Mathematics. A Defense Committee presides over the defense. The members of the Defense Committee are typically drawn from the Dissertation Committee, although substitutions are possible subject to the approval of the Dissertation Director. The Defense Committee must have at least four members. Three weeks prior to the defense, students inform the Department PS of their intention to defend, the scheduled date and time, and the committee composition. As with the Comprehensive Examination, at least two weeks prior to the exam GS must receive the *Announcement of Dissertation Defense* form which lists the exam committee members and carries the signature of the Department Chair. No defense can be held without properly filing this form. For details see the heading *The Final Examination for the Doctorate (Dissertation Defense)* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`. Candidates should submit a copy of their dissertation to each committee member in advance of the defense. Typically two weeks is sufficient time for review, although the candidate should confer with the committee and the relevant section of the graduate handbook includes the following.

> *The student is responsible for providing each member of the dissertation committee with a complete copy of the dissertation in ample time for review prior to the examination.*

The final defense is public and open to all who wish to attend. Announcements must be posted in advance.

To graduate in a given semester, PhD students and the Department must provide the following to GS by November 15 for Fall graduation, April 15 for Spring graduation, or July 15 for Summer graduation.

- Report of the results of the final oral defense
- Final version of the dissertation. See *Electronic Submission of the Dissertation* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`.
- *Report on Dissertation* form from each Committee Member.
- *Survey of Earned Doctorates*.

See the sections *Electronic Submission of the Dissertation* and *Accompanying Forms* at `http://catalog.unm.edu/catalogs/2015-2016/graduate-program.html`. Guidelines for electronic submission of the thesis to LoboVault may be found at `http://grad.unm.edu/degree-completion/thesis-dissertations/lobovault.html`.

4 Further information

4.1 Required forms

For a complete list of forms and timelines, visit `http://grad.unm.edu/resources/gs-forms/index.html`. Please submit all forms to the Department PS who will then make copies for your academic file and submit originals to GS. Not following protocol my result in an untimely granting of your degree.

4.2 Graduation

4.2.1 Deadlines

For each graduation semester a list of proposed graduates from the Department is due at GS by the second full month of the *prior* semester. Therefore, if you plan to graduate in May, then to have your name on the graduation list you must notify the Department PS before 1 October of the Fall semester. In order to complete graduation requirements for the semester the examination-results report for the Thesis or Dissertation must be signed and submitted to GS by November 15 for Fall, April 15 for Spring, and July 15 for Summer. Each is a hard deadline; you will be graduating at least a semester later unless you meet it.

4.2.2 Ceremony

Degrees are awarded three times a year: December, May, and July or August. However, the University of New Mexico holds only two formal ceremonies; those Convocations are in December and May. Students who complete their degrees in the summer may walk in the May ceremony before the degree is completed or the December ceremony following completion of the degree requirements. The annual Department commencement is in May.

4.3 Time limits

MS. GS dictates that all work toward a Master's degree must be completed within a 7 year period beginning from the first graduate course taken in an approved program, including any transfer credit from another institution.

Graduate Program Timeline

Year 1		Year 2		Year 3		Year 4		Year 5	
Semester 1	Semester 2	Semester 3	Semester 4	Semester 5	Semester 6	Semester 7	Semester 8	Semester 9	Semester 10
Start MS coursework	Preliminary attempt of MS/PhD QEs (before semester)	Select Master's Thesis Committee (Plan I)	Announce Master's Exam (Thesis Defense or Written QEs) 2 weeks prior	Completion of MS/PhD QEs (before semester)	Submit *Application for Candidacy* form	Start Dissertation hours	Intent to graduate due*	Intent to graduate due*	Complete Dissertation
Announce intent to make Preliminary attempt of MS/PhD QEs		Intent to graduate due*	Complete and defend Thesis	Select Committee on Studies	Comprehensive Exam	Submit form for approval of non-UNM committee member		Apply for jobs	Apply for jobs
			Submit Thesis to LoboVault	Start PhD coursework	Certification of Language Requirement				Submit Dissertation to LoboVault
					Select Dissertation Committee				

*Due to the Department the semester BEFORE you intend to graduate.

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PhD. Doctoral candidates have 5 years for completion of all degree requirements from the semester in which they pass their Doctoral Comprehensive Exam. This time limit includes the oral defense and submission of the final dissertation. GS rules dictate that a PhD must be completed in 10 years total.

Students may request extensions of these time limits only in writing. A request must be supported by the Department and approved by the Dean of Graduate Studies. Extensions are not automatic; students must demonstrate progress toward completion of degree requirements and fill out the necessary petitions for extensions.

4.4 Leave of absence and readmission

The leave of absence is a Department policy. Should a leave become necessary, students must contact their FA before beginning the leave of absence from coursework. Students must then notify the Department PS in writing about the timing and intended length of the leave. Dissertation students planning a leave of absence must petition GS, or they will be responsible for paying tuition costs for the semesters not in attendance. Leaves are granted for catastrophic circumstances only and for a total of one year.

A student who is admitted and completes at least one semester of graduate studies in the Department is allowed three subsequent semesters (including Summer) without taking classes. An absence of more than three semesters will result in the student being automatically dropped from the program. In this case, the application form for readmission must be filed with the Department by the application deadline for the semester in which the student will be returning: April 30 for Fall and November 1 for Spring.

Students should keep in mind that absences from graduate study are included in the MS and PhD time limits. Once enrollment for 599 (Thesis) or 699 (Dissertation) has begun, continuous enrollment must be observed (see Subsections 2.6.2 and 3.8.2 above).

4.5 Teaching Assistant duties

TAships are made with the expectation that the TA will be a successful and responsible teacher. In particular, TAs should understand the following.

- The TA must be physically present in the Department on the beginning date (generally one week before the beginning of the semester) of their contract for training, orientation, and course assignment. Failure to do so without an acceptable justification may result in the termination of their TA contract. TAs must also be physically present in the Department until the end of their contract, usually the last Friday of the semester.
- Usually the TA is expected to teach one section of a lower division course or conduct two recitation sections of Calculus for a professor. The TA also needs to be available for at least 3 hours per week for office hours. The TA assignment may also include the grading of homework and exams. TAs working in recitation for a professor may be required to attend some of the professor's lectures.
- First time TAs are required to take the Graduate Mathematics Teaching Seminar offered by the Department. In the seminar other TAs are welcomed to share teaching experiences.

- The Department expects TAs to be fluent in spoken English. In particular, a TA should be easily understood by their class, and they must themselves be able to understand questions frequently expressed in colloquial English. A high score on the TOEFL does not guarantee the degree of fluency necessary to teach a class. International students may need a course in English as a Second Language (ESL); these are offered through the English Department. Based on their TOFEL scores, international students may be placed in English 110 and/or English 120. For information about ESL, please contact Gloria Sands, *Program Coordinator* in *English-Core Writing*, at (505)277-5576. If communication continues to be a problem in one of your classes, then failure to avail yourself of opportunities to improve your spoken English may result in termination of your TA.
- The Department will usually support TAs/RAs pursuing a Master's degree for a maximum of 6 semesters, and for those pursuing a PhD entering with a BS for a maximum of 10 semesters. For students entering the program with an MS in Mathematics and Statistics the maximum time allotted for financial support with a TA/RA in the Department is usually 6 semesters.
- From time-to-time the Graduate Committee takes these semesters of support under consideration and these limits are subject to change according to the consensus of the Committee. One criteria for setting time limits is the suitable progress of graduate students, and whether or not these limits are conducive or detrimental to timely completion of graduate degrees.

Graduate student TAs/RAs should realize that TAship/RAship renewal is not an automatic process. Apart from timely performance on the MS/PhD QEs, the main criteria governing renewal of assistantships are the following.

- Steady progress toward an advanced degree in Mathematics. TAs are expected to register for 9 credit hours each semester. These must be in classes directly related to the academic degree.
- Effective teaching and/or fulfillment of associated research responsibilities.

4.6 Resources

4.6.1 Library and electronic journals

UNM's Centennial Science and Engineering Library houses an excellent collection of books and journals. Among other services the library provides electronic access to both `JSTOR`, an electronic repository of older journals, and numerous current journals. We have free access to `MathSciNet` (Mathematics Reviews on the Web).

4.6.2 Computational facilities

The Department currently maintains approximately 120 desktop computers; faculty offices have at least one computer, and all graduate student offices (usually shared) have at least two. The Department houses a 12-computer lab accessible night-and-day via access cards. It maintains three classrooms in the SMLC with computers and projection systems for

instructional use. Laptops are also available for classroom use. The Department has 8 printers accessible by all its computers.

To obtain a Department computer account, please visit `https://www.math.unm.edu/computerResources/computerAccount.php`. If you are a registered graduate student, then you may enter the Department PS as the sponsor for your account.

Research computing at UNM is supported by the Center for Advanced Research Computing (CARC). CARC maintains a number of clusters dedicated for research. CARC also holds tutorials and workshops on high-performance computing, and it maintains an in-house visualization and parallel computing laboratory. For details please visit `https://www.carc.unm.edu/`.

4.6.3 National labs

UNM's proximity to both Sandia National Laboratories and Los Alamos National Laboratories facilitates interactions between laboratory researchers and both UNM faculty and students. Some of our graduate students hold internships at the labs or are involved with other collaborations. Some have moved on from UNM to permanent research positions at the labs. Students are encouraged to explore these possibilities.

4.7 Societies, associations, and external resources

American Mathematical Society

201 Charles Street
Providence RI 02904-2294 USA
tel: 401-455-4000 worldwide; 800-321-4267 in USA and Canada
fax: 401-331-3842
`ams@ams.org`
`http://www.ams.org`

American Statistical Association

732 North Washington Street
Alexandria VA 22314-1943 USA
tel: (703) 684-1221 or (888) 231-3473
fax: (703) 684-2037
`sainfo@amstat.org`
`http://www.amstat.org`

Association for Women in Mathematics

11240 Waples Mill Road, Suite 200
Fairfax VA 22030 USA
tel: 703-934-0163
fax: 703-359-7562
`awm@math.umd.edu`
`http://www.awm-math.org`

Institute for Operations Research and the Management Sciences (INFORMS)
5521 Research Park Drive, Suite 200 (On the campus of University of Maryland, Baltimore County, Hussman Building)
Catonsville MD 21228 USA
tel: 800-4INFORMS
informs@informs.org
http://www.informs.org

Mathematical Association of America (Headquarters)
1529 18th Street NW
Washington DC 20036-1358 USA
tel: (202) 387-5200 or (800) 741-9415
fax: (202) 265-2384
maahq@maa.org
http://www.maa.org

Mathematical Association of America (Service Center)
tel: (301) 617-7800 or (800) 331-1622
fax: (240) 396-5647
maaservice@maa.org

National Council of Teachers of Mathematics
1906 Association Drive
Reston VA 22091-1502 USA
tel: (800) 235-7566 or (703) 620-9840
fax: (703) 476-2970
NCTM@nctm.org
http://www.nctm.org

Repository of Electronic Preprints in Mathematics
https://arxiv.org/archive/math

Society for Industrial and Applied Mathematics
3600 Market Street, 6th Floor
Philadelphia PA 19104-2688 USA
tel: +1-215-382-9800 or 800-447-SIAM (US and Canada)
fax: +1-215-386-7999
service@siam.org;membership@siam.org;siambooks@siam.org