

Graduate Handbook for Mathematics University of New Mexico 2009-2010



“Visitor” from the UNM *Quantum*, 2001 edition

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CONTACT INFORMATION

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GRADUATE DEGREES OFFERED

The Department of Mathematics and Statistics offers a Master in Science (M.S.) in Mathematics and a Doctor in Philosophy (Ph.D.) in Mathematics. Each of these degrees can be in the concentration of Pure Mathematics or Applied Mathematics. We are working towards creating a M.S. in Math Education degree, and eventually also a Ph.D. in Math Education.

The M.S. in Mathematics is awarded under either Plan I: 26 hours and 6 hours thesis or Plan II: 32 hours. Under Plan II instead of writing a thesis, students must pass the M.S./Ph.D. Qualifying Exam at master's level. To enter the Ph.D. program, students must pass this same exam but at a higher level, hence the Ph.D. qualifying examination requirements are the same as those listed for M.S. Plan II. After passing the Qualifying Exam the Ph.D. candidate must fulfill 18 more hours of course credits, pass the Doctoral Comprehensive Exam, fulfill a language requirement, accumulate at least 18 hours of dissertation credits, and finally submit and defend his/her dissertation.

The general requirements for both the M.S. and Ph.D. in Mathematics degrees are given in the UNM Catalog 2009-2010, starting on p.55. Specific academic requirements, necessary paperwork, and deadlines are discussed and described in detail in this handbook.

The Department also offers both M.S. and Ph.D. in Statistics, but this handbook is dedicated to the graduate degrees in Mathematics. The Graduate Handbook in Statistics can be found on the web at http://www.stat.unm.edu/stats_grad_prog.html.

APPLICATION DEADLINES

Applications must be received by the Office of Graduate Studies no later than February 15 for those seeking financial assistance or April 30 for all others to be considered for the fall term, and no later than November 1, to be considered for the spring term. Review of completed applications is done on a rolling basis, beginning on February 15 for the fall term, and beginning on November 1 for the spring term. Applicants seeking teaching assistantships are strongly encouraged to apply as early as possible.

FINANCIAL AID AWARDS

The Department awards a number of Teaching Assistantships and a limited number of Research Assistantships each year. Most teaching assistantships are awarded in the mid-semester in the spring to applicants who then begin their duties in the fall. Individuals seeking a teaching assistantship are strongly encouraged to apply early. The Office of Graduate Studies administers all assistantships. According to the Office of Graduate Studies' Policy for the Administration of Assistantships, "To be employed as a Teaching Assistant (TA), Graduate Assistant (GA), Teaching Associate (TAssoc.), Research Assistant (RA), or Project Assistant (PA), a student must have held no more than 12 semesters of employment as a TA, GA, TAssoc, RA, or PA alone or in combination." For more information see the section "Financial Assistance and Support Programs", UNM Catalog 2009-2010, starting on p.65.

The department has also a limited number of research assistantships available in conjunction with the Albuquerque High Performance Computing Center (AHPCC). Application information is available at <http://www.ahpcc.unm.edu>.

In addition, the University of New Mexico has a variety of financial support programs and fellowships, several of them for underrepresented groups. Information on additional sources of financial support is available from the Financial Aid Office (505) 277-2041 or the Office of Graduate Studies (505) 277-2711.

SELECTION CRITERIA FOR TEACHING ASSISTANTSHIPS

The Graduate Committee is responsible for awarding teaching assistantships and also for determining which graduate students should be retained as teaching assistants.

The following criteria are used in evaluating applicants for teaching assistantships. An applicant should have:

- An undergraduate major in mathematics or statistics or a closely related area of scientific study.
- A high grade point average in undergraduate courses; particular attention will be given to mathematics and statistics courses.
- Strong letters of recommendation.
- A strong potential for academic achievement at the graduate level.
- A strong potential for teaching beginning courses in mathematics and statistics.
- A desire to participate in and contribute to a culturally diverse academic environment.
- In the case of foreign applicants, a high score on the Test of English as a Foreign Language (TOEFL). Currently the minimum for Admission to UNM on the TOEFL paper based exam is 550, the computer based exam is 213, and the new Internet Based TOEFL (IBT) is 79.

The General GRE is no required at this time; however, to be competitive for the Teaching Assistantships it is recommended that students consider taking the Subject GRE in Mathematics.

ADVISING

Each graduate student in the Department is required to report to the Graduate Chair, Dr. Alexandru Buium, and to the Department Coordinator of Program Advisement, Roxanne Littlefield. Students will be assigned a Faculty Advisor by the Graduate Chair. Each semester, the Faculty Advisor must approve the student's program of studies. ***All graduate students will have a registration hold for advisement that will be lifted by the Department Coordinator of Program Advisement when advisement documentation from the Faculty Advisor is received.*** This hold will be instituted around the 12th week of each semester. Any student who fails to obtain the Faculty Advisor's approval for his/her program of studies each semester may be subject to dismissal from the program. A student can change advisors by contacting the Graduate Chair or the Department Coordinator of Program Advisement.

THE MASTER'S DEGREE

GENERAL REQUIREMENTS

The Master of Science degree is awarded based on one of two plans as described below. Plan I is the thesis option, while Plan II is the non-thesis option. In addition to the general requirements for Plans I and II, the Department also imposes a number of requirements that are specific to the options of Pure or Applied Mathematics. While a student may choose a minor field of study in consultation with an advisor, there is no formal minor requirement for the Master's degree in Mathematics. Knowledge of a foreign language is not required, but is encouraged.

PLAN I

- A minimum of 26 hours of course work at the 400 (400 level courses must be offered for graduate credit and do not include Math 401/501 or 402/502) or 500 level in Mathematics and Statistics and related fields. At least 20 of these hours must be within the Department, and of these, at least 12 hours must be at the 500 level.
- At least 50% of course requirements must be completed after admission to the graduate program. The Department will accept up to twelve 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 course work required in Plan I.
- The Final Examination will be a defense of the thesis. This defense is in lieu of the M.S./Ph.D. Qualifying Examination required under Plan II.

PLAN II

- A minimum of 32 hours of course work at the 400 (400 level courses must be offered at the graduate level and do not include 401/501 or 402/502) or 500 level in Mathematics and Statistics and related fields. At least 26 of these hours must be within the Department, and of these, at least 12 hours must be at the 500 level.
- At least 50% of course requirements must be completed after admission to the graduate program. The Department will accept up to twelve hours of non-degree credits in Mathematics.
- A maximum of 12 hours in "problems" or "individual study" courses, with a maximum of 6 hours with any one instructor in accordance with UNM Catalog provisions.
- Passing the M.S./Ph.D. Qualifying Exam at the Master's level.

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 UNM Catalog 2009-2010, p.75 for further details. The form for the Program of Studies may be found at <http://www.unm.edu/~grad/forms/forms.html>.

AREA REQUIREMENTS

Master's degree programs are offered in Pure or Applied Mathematics. These programs are designed to provide the student with a broad technical background that would be appropriate for employment in industry or government, or for doctoral studies in mathematics or statistics. Specific requirements for the master's degree in the Pure and Applied Mathematics options are detailed in the following descriptions.

Students who are interested in Mathematics Education can take some of their elective courses in education and/or pursue the Master's thesis option instead of taking exams. Since we do not have yet an official degree in Mathematics Education, students are asked to talk to their faculty advisors about this option if they are interested.

A companion handbook describes the corresponding specific requirements for the Statistics option.

PURE MATHEMATICS

Admission Requirements

A bachelor's degree in mathematics or a related area is required for admission. Undergraduate courses should include (the equivalent of) at least one semester

each of linear algebra and abstract algebra and one semester of advanced calculus.

Course Requirements

Under Plan I, a minimum of 26 hours of course work plus 6 hours of thesis is required. Under Plan II, a minimum of 32 hours of course work at the graduate level is required. Under either plan, up to 6 of these hours at the graduate level may be taken outside of the department. Under both plans the graduate course work concentrates in mathematics, and must be approved by the student's Faculty Advisor. 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

Completion of all these courses will ensure the student has acquired a sound and solid mathematical foundation, and therefore is highly recommended. Substitutions for these courses can be made, but they require the approval of the student's Faculty Advisor and Graduate Committee.

Examination Requirements

The examination for those students working under the Plan I requirements is a defense of the 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.

Students pursuing the M.S. under Plan II will have two attempts to pass the M.S./Ph.D. Qualifying Examination. A higher standard of performance on these examinations is required for a student to pass at the Ph.D. level.

The M.S. /Ph.D. Qualifying Examination in the concentration in Pure mathematics consists 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 good foundation for the material covered by the examinations. Syllabi, references, and previous exams are available in the department's main office as well as on the department's website at <http://www.math.unm.edu>.

Any student who is awarded a Master's degree under Plan I, and wishes to pursue the Ph.D. degree must take the M.S./Ph.D. Qualifying Examination.

APPLIED MATHEMATICS

Admission Requirements

Applicant 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.

Course Requirements

Under Plan I, a minimum of 26 hours of course work plus 6 hours of thesis is required. Under Plan II, a minimum of 32 hours of course work at the graduate level is required. Up to 6 hours of graduate level courses may be taken outside of the department. Under both plans the graduate course work concentrates in mathematics and scientific applications and must be approved by the student's advisor. In addition, completion of the following courses, or their equivalent in transfer credit is required under both plans:

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

It is also recommended that students under Plan II complete the following courses, or their equivalent in transfer credit:

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

Completion of all these courses will ensure the student has acquired a sound and solid mathematical foundation, and therefore is highly recommended. Substitutions for these courses can be made, but they require the approval of the student's Faculty Advisor and Graduate Committee.

Examination Requirements

The examination for those students working under the Plan I requirements is a defense of the 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.

Students pursuing the M.S. under Plan II will also have two attempts to pass the M.S. Examination. The Master of Science and Ph.D. Qualifying Examination are the same and are required for those students working under the Plan II requirements. A higher standard of performance on the examination is required for a student to pass at the Ph.D. level.

The M.S. and Ph.D. Qualifying Examination in the concentration in Applied mathematics consists 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 good foundation for the material covered by the exams. Syllabi, references, and previous exams are available in the department's main office and at the department's World Wide Web pages (<http://www.math.unm.edu>).

Any student who is awarded a Master's degree under Plan I, and wishes to pursue the Ph.D. degree must take the Ph.D. Qualifying Examination.

APPLICATION FOR CANDIDACY

After 15-18 hours of residence graduate credit, students request the form for Program of Studies from the Departmental Coordinator of Program Advisement. In consultation with the student's Faculty Advisor, the candidate lists completed and projected course work and declares election of either Plan I (thesis) or Plan II (non-thesis). The application is then returned to the Coordinator for signatures by the Faculty Advisor and by the Chair of the Department before being sent to OGS for the approval by the Dean of Graduate Studies.

MASTERS THESIS (PLAN I)

Master's Thesis Committee

Note: Any student may pursue the M.S. under either Plan I or Plan II; however, students not intending to complete their education at the M.S. level are encouraged to work under Plan II.

Any student pursuing the M.S. under Plan I needs to form a Thesis Committee to oversee his/her progress and examination. The student should consult with his/her Advisor about serving as chair of the Thesis Committee. Additionally, the student needs to obtain the consent of two other faculty members to serve as members of the thesis committee.

For the university policies regarding Master's Thesis, Thesis Committee, Submission of the Thesis and Thesis Format, consult the UNM Catalog 2009-2010, pp.76-77.

At this time, OGS has no forms for officially forming a master's thesis committee, but the Department Coordinator of Program Advisement should be notified in writing.

Master's Thesis Credit Hours

Students opting for the M.S. with thesis must complete a minimum of six (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 OGS approves the thesis. Thesis candidates must be enrolled the semester in which they complete degree requirements, including summer sessions.

Master's Thesis Defense and Submission

At least two weeks prior to the Thesis Defense, and no later than November 1 for fall, April 1 for spring or July 1 for summer, the Department must notify the OGS of the Master's Thesis scheduled defense date by submitting the appropriate announcement form. This form will be completed and submitted by the Department Coordinator of Program Advisement.

The intention to defend should be made to the Coordinator at least three weeks prior to the defense so that the appropriate forms are submitted in a timely manner to OGS.

Two copies of the thesis manuscript must be submitted for approval from OGS. A third copy must be submitted to the Department for our archives. These copies should not be bound.

EXAMINATION PROCEDURE (PLAN II and Ph.D. Qualifying)

Graduate (Preliminary, and M.S./Ph.D.) Qualifying Examinations are given in the areas of Algebra, Real Analysis, Complex Analysis, Geometry/Topology, Differential Equations and Numerical Analysis. Every examination is based on a syllabus available in the advisement office or online. Syllabi and previous examinations are available in the web at <http://www.math.unm.edu>.

The student is responsible for the material on the exam syllabus, regardless of whether or not the material was covered in a recent course. Likewise, exam composers should restrict themselves to ask questions on material that is part of the official syllabus, regardless whether a particular topic (not included in the syllabus) was covered in a recent course. It is recommended that students review these materials well in advance of the exams.

Students must take exams in three areas. It is the students' responsibility to make sure that the exams taken are acceptable for their chosen program (pure or applied). The Preliminary and M.S./Ph.D. Qualifying Examination consist of the same problem sets. The passing grade differs according to level; that is, a lower grade is sufficient to pass at the Master's level than at the Ph.D. level.

Graduate Examinations are administered twice a year, just prior to the start of the Fall and Spring semesters. The exact dates are announced and posted on the Department website <http://www.math.unm.edu>, in April for the Fall exam and in

November for the Spring exam. Upon announcement of the exams, and no later than three weeks prior to administration of the exams, the student, with the approval of his/her advisor, must register for the exams he/she intends to take on the department website <http://www.math.unm.edu>.

Preliminary Examinations

Full-time graduate students enrolled in the Master's program under plan II (or intending to qualify for the Ph.D. program) who wish to take the Preliminary Examinations must do so before the beginning of the second semester of their graduate program. The purpose of these exams is to assess the student's initial progress. Should the student obtain a grade of M.S. pass (Ph.D. pass) in some or all the Preliminary Exams, the student earns a waiver for the corresponding part of the Master's (Ph.D.) Qualifying Exam.

Taking the Preliminary Examinations does not count as one of the student's two attempts to pass the M.S./Ph.D. Qualifying Examination.

Students who pass the Preliminary Exam in all three areas at the desired level must still sign up (see below) for the Master's or Ph.D. Qualifying Exam to comply with the rules of the Office of Graduate Studies. However, they are not required to take any of the written exams and are given a passing grade pro forma. For other students, the content of the Master's (Ph.D.) Qualifying Examinations consists of 1 to 3 exams based on the student's performance in the Preliminary Examination.

Deadline for Completion

Before the beginning of the fifth semester of full-time graduate study a student enrolled in the Master's program under plan II (or intending to qualify for the Ph.D. program) must have completed the Master's (Ph.D.) Qualifying Examinations.

Students have a maximum of 2 consecutive tries to pass the exams at the required level. (The preliminary exam is not counted as one of the tries.) The second attempt at these exams must be taken within **one semester** of the first. Students, who at the end of the second try, have not passed all exams at the required level are typically disenrolled from the program. Students may appeal to the Graduate Committee to be allowed to continue, but such appeals are only approved under special circumstances.

The Graduate Committee typically requires teaching and research assistants to complete the exams before the beginning of the fifth semester of the graduate program as a condition of continued support.

Students may request delaying the Preliminary, or M.S./Ph.D. Qualifying Examination. The Department Graduate Committee must approve this request. The Graduate Committee will only approve such requests under special circumstances, for example, for students admitted with deficient backgrounds or health reasons.

It is the consensus of the Faculty in the Department that the Qualifying Exam is an indicator of a graduate student's ability to write a Ph.D. dissertation. The rules for these exams are fairly stringent. They are especially meaningful for graduate students who receive funding in the Department via a Teaching or Research Assistantship.

Students attempting to qualify for the Ph.D. program have a maximum of 2 consecutive tries to pass all required exams at the Ph.D. level. (The preliminary exam is not counted as one of the tries.) Students, who at the end of the second try, have not passed all required exams at the Ph.D. qualifying level are typically disenrolled from the program. However, a student attempting to qualify for the Ph.D. program may still graduate with a M.S. if he/she passes the exams at the M.S. level or higher. Students may appeal to the Graduate Committee to be allowed to continue, but such appeals are only approved under special circumstances.

Part-time and Transfer Students

Part-time students are required to develop a reasonable timetable for completing their exams. The Graduate Committee must approve timetables recommended by the faculty advisor.

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

THE DOCTORAL DEGREE

The goal of the Ph.D. program is for the student to write a dissertation that makes a contribution to mathematics. To do this, the student must become familiar with the breadth of current research topics. The student taking advanced courses, participating in research seminars, attending colloquia, and talking to the faculty does this. Attending colloquia is particularly important; the department provides colloquia on many current research topics given by active researchers from around the world. Students should read the descriptions of the faculty interests; when topics of interest are found, the student should ask the faculty member for reading material on that topic.

ADMISSION TO THE DOCTORAL PROGRAM

Students already admitted to graduate study in mathematics or statistics enter the Ph.D. program by passing the Ph.D. qualifying examination. For UNM students who are candidates for the Master's degree, the Master's examination and Ph.D. qualifying examination are the same. Thus, the Ph.D. qualifying examination requirements are the same as listed in the section on the Master's Degree, but the expectation for prospective Ph.D. students is that the exam material will be mastered in more depth and breadth. For students who transfer to UNM with a

Master's degree from another institution, it is required that they take the Ph.D. qualifying examination as soon as practical, and in no case later than one year after admission. If such a student has passed a qualifying exam in Mathematics or Statistics at another institution, the student may petition the Graduate Committee for an exemption from the qualifying exam requirement. Each student who passes the Ph.D. Qualifying Exam should arrange for a Committee on Studies to be appointed. This is done in consultation with the Graduate Committee and as soon as possible after the qualifying examination requirement is satisfied. The chairperson of the committee on studies becomes the student's Faculty Advisor.

GENERAL REQUIREMENTS

The first phase of the doctoral program requires a minimum of 18 semester hours of work 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. It is also required that proficiency in a language other than English be attained (see the following section on "Language Requirement" for full details) When these requirements are satisfied, the student will take the comprehensive examination. In Mathematics this is usually an oral examination. The purpose of the examination is to test the student's knowledge of the foundations of the area in which dissertation work is to be undertaken. Upon passing the 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 awarding of the highest academic degree.

AREA REQUIREMENTS

PURE

The Program of Studies in Pure Mathematics is designed by the student and the Committee on Studies, and will depend 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, harmonic analysis, and operator theory. We have experts who are recognized worldwide for their research in these areas.

It is expected that the student in the Ph.D. program in Pure Mathematics knows the course material required for the M.S. program. In addition to the M.S. course requirements, the 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, therefore they are required to get

- Credit for Attendance in at least four Department Seminars.

APPLIED

The Program of Studies in Applied Mathematics is designed by the student, and the Committee on Studies, and will depend on the research interests of the student. The Program of Studies is flexible and encourages interdisciplinary interaction with other departments; current areas with interdisciplinary interaction include scientific computing, fluid and solid mechanics, mathematical biology, non-linear optics, dynamical systems, material science and psychology. It is expected that the student in the Ph.D. program in Applied Mathematics knows the course material required for the M.S. program. In addition, the program of studies for the Ph.D. 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, therefore they are required to get:

- Credit for Attendance in at least four department seminars.

APPLICATION FOR CANDIDACY, Ph.D.

After 18-21 hours of doctoral course work and successfully passing the Ph.D. Qualifying Exams, students secure a form for Application for Candidacy from <http://www.unm.edu/~grad/forms/forms.html> and turned in to the Department Coordinator of Program Advisement. In consultation with the student's Committee Chair on Studies, the candidate lists completed and projected course work. At this time, the student also formally declares a Committee on Studies. The application must be returned to the Coordinator signed by the entire Committee on Studies and must be signed by the Department Chair before being forwarded to OGS for approval. This roughly coincides with the timing of taking the Comprehensive Exam

COMMITTEE ON STUDIES

Each doctoral student is required to have a Committee on Studies, which should eventually become the core of the Dissertation Committee. A committee should be chosen *immediately after passing Ph.D. Qualifying Exam*. The Committee

should consist 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 student's chair and one other member must be from his/her option and one member can be from outside the department). All members must be tenured or tenure-track faculty at an accredited institution.

At the time of candidacy approval, Committee composition requires final approval from the Graduate School Dean and at that time becomes the Dissertation Committee. The Dissertation Committee will need to include one additional committee member from outside the Department, if the Committee on Studies does not include one already. The Announcement of Dissertation Committee form may be obtained at <http://www.unm.edu/~grad/forms/forms.html> and should then be turned in to the Department Coordinator of Program Advisement.

The chair and/or members of the Ph.D. 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 Coordinator of Program Advisement of the changes.

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

- To meet with the student at necessary intervals.
- To establish prerequisites and review deficiencies.
- To plan with the student, approve and direct an integrated program including work in the necessary supporting fields, if any.
- To recommend transfer of credit.
- To approve the Application for Candidacy.
- To determine the individual doctoral requirement in foreign languages and/or other technical skills.
- To act as the Doctoral Comprehensive Examination Committee.
- To recommend that the student shall or shall not be advanced to Candidacy.

LANGUAGE REQUIREMENT

It is expected that each doctoral student in pure or applied mathematics will attain proficiency in one foreign language, chosen from French, German, or Russian. Substitution of another language, such as Spanish, 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 by the student to substitute another requirement relevant to the research area.

The language requirement may be satisfied by one of the following:

- Completing three semesters in the language as an undergraduate with at least a C average and with a grade of C or better during the third semester.

- Completing MCL 365, 366 "Language Reading for Graduate Students" in the chosen language with a grade of B or better in both courses.
- Passing a standard examination, such as ETS, in one of the languages
- Passing a departmental language examination

COMPREHENSIVE EXAM

This is usually an oral examination conducted by the Committee on Studies. The purpose of the examination is to test the student's knowledge of the foundations of the area in which dissertation work is to be undertaken.

See the section "Doctoral Comprehensive Examination", UNM Catalog 2009-2010, p.81 for details. Students are expected to pass their Comprehensive Exam within 3 to 4 semesters after passing the Qualifying Exam.

DISSERTATION

DISSERTATION COMMITTEE

Doctoral students formally constitute a Dissertation Committee after successfully passing the Doctoral Comprehensive Examination. The core of this committee is typically, but does not have to be, the same as the Committee on Studies. Students initiate the 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" form, which can be found online at <http://www.unm.edu/~grad/forms/forms.html>.

This form requires the signature of the candidate and the Dissertation Committee Chair. Then it should be turned in to the Coordinator of Program Advisement for signatures of the Department Chair and the Dean of OGS.

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 UNM Catalog 2009-2010, p.82 for details on the committee and categories of committee members.

DISSERTATION CREDIT HOURS

The program for the doctorate includes a minimum of 18 hours of dissertation (699) credit, see Section IV in this handbook for details in the Ph.D. program. 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 OGS approves the dissertation. Doctoral candidates must be enrolled the semester in which they complete degree requirements, including summer sessions.

Enrollment in 699 dissertation hours may not begin prior to the semester in which Comprehensive Exams are taken. The cost of dissertation hours is the same for 3 to 18 hours. Check current tuition rates for dissertation hours rates.

DISSERTATION PROGRESS

Once the dissertation proposal has been approved, the Dissertation Committee will deal with 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 conducting the defense.

DISSERTATION FINAL DEFENSE AND SUBMISSION

A final oral presentation covering the dissertation and its relationship to Mathematics is required. The examination committee must have at least four members. The Defense Committee will ordinarily be the same as the Dissertation Committee. Substitutions can be made only with the approval of the dissertation director. Three weeks prior to the defense, students should inform the Department Coordinator of Program Advisement of their intention to defend, the scheduled date and time, and the committee composition. As with the Comprehensive Exams, OGS must receive the "Announcement of Dissertation Defense" form listing the exam committee members and signed by the Department Chair at least two weeks prior to the exam. No defense can be held without properly filing this form. UNM Catalog 2009-2010, pp.83-84, for details. Candidates should also note that the *UNM Catalog: Graduate Program* directs that a complete copy of the dissertation must be submitted to each member of the committee **at least two weeks** before the final defense.

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

In order to graduate in a given semester, the student and department must provide Office of Graduate Studies, by November 15, April 15, or July 15, with the following:

- Report of the results of the final oral defense
- Electronic Submission of the dissertation – See the tab labeled "Thesis and Dissertation" at <http://www.unm.edu/grad> for details and submission links.
- "Report on Dissertation" from each Committee Member
- "Survey of Earned Doctorates"

See the sections "Submission and Approval of the Dissertation" and "Accompanying Forms", UNM Catalog 2009-2010, p.84.

A copy of the dissertation in “final form” should also be submitted to the Department for archival purposes. This copy does not have to be an original and does not need to be bound. The Department Coordinator of Program Advisement is in charge of receiving and storing the dissertations.

Graduate Student 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 |
| Begin M.S. Coursework | Preliminary Exams (before semester starts) | Plan I – select Thesis Committee | Announce exam for thesis defence or quals two weeks prior | M.S./Ph.D Quals (before semester starts) | Submit form for Application for Candidacy | Begin Dissertation Hours | | | Finish Dissertation |
| Announce intent to take Prelims | | Intent to Graduate due* | Complete manuscript & defend thesis | Select Committee on Studies | Comprehensive Exam | Submit form for approval on non-UNM Committee Member | | | Apply for jobs |
| | | | Manuscript due to OGS | Begin Ph.D. Coursework | Certification of Language Requirement | Intent to graduate due* | | | Get ready for real life |
| | | | | | Select Dissertation Committee | | | | Manuscripts due to OGS |

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

Updated July, 2009

REQUIRED FORMS

For a complete list of forms and timelines, students should visit <http://www.unm.edu/grad/forms/forms.html>

All necessary forms should be submitted to the Department Coordinator of Program Advisement who will copy the form for the student academic file and submit the original to the Office of Graduate Studies. Bypassing regular channels will result in confusion and the probability that your degree will not be granted in a timely manner.

GRADUATION DEADLINES

A list of proposed graduates is due at the Office of Graduate Studies from the Department by the second full month of the semester preceding the intended graduation semester (i.e. if you plan to graduate in May you must notify the Coordinator of Program Advisement in the Fall semester before the first of October to have your name on the graduation list).

Report of Exam for Thesis or Dissertation must be signed and submitted to OGS by November 15 for fall, April 15 for spring, and July 15 for summer in order to complete graduation requirements for that semester. There is no deviation from these dates and should you fail to meet the deadline, you will be graduating the following semester.

ACADEMIC REQUIREMENTS

M.S. Plan I (Thesis)

Candidates complete their graduate work by fulfilling course work requirements, successfully defending the thesis, and submitting an approved thesis to the Department and OGS.

M.S. Plan II (Non-Thesis)

Candidates complete their graduation work by fulfilling course work requirements and successfully passing the qualifying examination.

Ph.D.

Candidates complete their graduate work by fulfilling course work requirements, successfully passing the comprehensive examination, and submitting an approved dissertation and report of dissertation defense to the Department and OGS.

CEREMONY

Degrees are awarded three times a year in December, May, and July or August. However, the University of New Mexico offers only two formal ceremonies and 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 departmental commencement is in May.

TIME LIMITS

Master's

Currently, OGS dictates that all work toward a Master's degree must be completed within a seven (7) year period beginning from the first graduate course taken in an approved program, including any transfer credit from another institution. The thesis must be submitted within 60 days of final defense.

Doctorate

A doctoral candidate has five years for completion of all degree requirements from the date he/she passes the Comprehensive Exam. This time limit includes the oral defense and submission of final dissertation copies to OGS. The dissertation must be submitted within 60 days of final defense.

A student may request an extension of this time limit only in writing. The request must be supported by the student's 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.

LEAVE OF ABSENCE AND READMISSION

The leave of absence is a departmental policy. Should a leave become necessary, students must contact their major faculty advisor before beginning the leave of absence from course work. Students must then notify the Department Coordinator of Program Advisement in writing about the timing and intended length of the leave. Dissertation students planning a leave of absence must petition the Office of Graduate Studies, or they will be responsible for paying tuition costs for the semesters not in attendance. These 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, including summer sessions, will result in a student being automatically dropped from the program. In this case, the application form for readmission must be filed with the Department by the application deadlines 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 M.S. and Ph.D. time limits. Once enrollment for 599 (Thesis) or 699 (Dissertation) has begun, continuous enrollment must be observed (see "Master's Thesis/Thesis Credit Hours" or "Doctoral Dissertation/Dissertation Credit Hours" above).

TEACHING ASSISTANT DUTIES

Teaching Assistantship appointments are made with the expectation that the Teaching Assistant will be a successful and responsible teacher. In particular, it is important that the Teaching Assistant (TA) understands the following points:

- The TA must be physically present in the department on the beginning date of their contract, (generally one week before the beginning of the semester) for training, orientation, and course assignment. Failure to do so without an acceptable justification may result in the termination of their teaching assistantship contract. TA 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 at least 3 hrs/week for office hours. The TA assignment may also include the grading of homework and exams. TAs working in recitation for a faculty may be required to attend some of the faculty's lectures.
- First time TAs are required to take the *Graduate Mathematics Teaching Seminar* offered by the Department. Other TAs are welcomed to share in the seminar their teaching experiences.
- The department expects their TAs to be fluent in spoken English. This is particularly important since a high score in the TOEFL test does not guarantee the necessary degree of fluency to teach a class. In particular, the TA should be easily understood by the class and must also be able to understand questions frequently expressed in colloquial English. International students are expected to take the accent reduction evaluation and classes if needed. These classes and scholarships are offered through the Department. Please speak to the Coordinator of Program Advisement if you feel you need these classes. In addition, the English Department also offers English as a Second Language (ESL) Writing courses through special sections of English 100, English 101, and English 102. Placement for these ESL classes requires a one-hour diagnostic placement essay that can be arranged with the Freshman English Staff Assistant in Humanities Building 213, 277-6347. The ESL sections have restricted access. Call numbers for these sections are posted in the English Department outside Humanities 213. For additional information contact 277-5426. Failure to avail oneself of the many avenues available for improvement of spoken English may result in termination of one's Teaching Assistantship if the problem of classroom comprehension continues.
- The Department will support TA's/RA's pursuing a Master's degree for a maximum of 5 semesters and for those pursuing a Ph.D. entering with a B.S. for a maximum of ten semesters. For students entering the program with an M.S. in Mathematics and Statistics the maximum time allotted for financial support with a TA/RA in the Department is 8 semesters.
- The Graduate Committee takes these semesters of support under consideration from time to time and these limits are subject to change according to the consensus of the Committee. One of the criteria on the time limits is the suitable progress of the graduate students and whether or not these limits are conducive or detrimental to timely completion of graduate degrees.

It is important for a graduate student who is also a TA/RA to realize that the renewal of a teaching assistant/research assistant contract is not an automatic process. The two main criteria apart from passing Qualifying exams in a timely manner for renewing an assistantship are:

- Steady progress toward an advanced degree in mathematics. Teaching assistants are expected to register for 9 credit hours each semester. These must be in classes directly related to the academic degree.
- High quality teaching performance and the fulfillment of associated responsibilities or high work performance in the research area funded.

RESEARCH FACILITIES

There is an excellent collection of books and journals in the Centennial Science and Engineering Library. Among other services, the library has J-STOR an electronic repository of old journals, as well as numerous current journals available electronically. We have free access to MathScinet (Mathematics Reviews on the Web), as well as many other electronic resources.

To obtain a Mathematics Department computer account. Go to <https://www.math.unm.edu/computerResources/computerAccount.php>. You may put Roxanne Littlefield as your sponsor for this account if you are a registered graduate student.

Department of Mathematics and Statistics: Computing Overview

The department's computing facilities include multiple computers and workstations (a mix of Suns, SGI workstations, and dual boot Linux/windows PCs) on a common dual firewalled secure network.

Linux/Unix CPU servers are available remotely; via SSH login for running large jobs or remote access from outside the math dept.

The Department also supplies windows statistical software for a separate fifty-seat instructional computing laboratory, lobo lab and other CIRT managed areas. The University has additional local computing services available to Department students and personnel in the form of, linux/windows PCs, and Macs that are administered by CIRT.

UNM also manages the Albuquerque High Performance Computing Center (formerly know as ARC) which presents tutorials and workshops on high-performance computing and maintains an in-house visualization and parallel computing laboratory.

Geographical proximity to the Sandia National Laboratories and Los Alamos National Laboratories fosters interactions between UNM Faculty and laboratory researchers. Some of our graduate students have had internships at the laboratories as well as other types of collaborations, including obtaining permanent jobs as researchers there. Students are encouraged to explore these options.

GRADUATE FACULTY RESEARCH INTERESTS

A list of Department faculty and their areas of interest follows. A brief resume and publication list for each faculty member may be inspected on the Mathematics Department website at www.math.unm.edu.

CHAIR

Alexander P. Stone, Ph.D., University of Illinois, 1965. Differential geometry, differential equations, electromagnetic theory.

PROFESSORS

Alejandro Aceves, Ph.D., University of Arizona, 1989. Nonlinear optics, theory of solutions.

Edward J. Bedrick, Ph.D., University of Minnesota, 1984. Categorical data analysis, Computational Statistics.

Charles P. Boyer, Ph.D., Pennsylvania State University, 1972. Differential geometry, mathematical physics, relativity, gauge theories.

Michael A. Buchner, Ph.D., Harvard University, 1974. Singularity theory, real algebraic geometry.

Alexandru Buium, Ph.D., University of Bucharest, 1983. Differential algebraic geometry, Diophantine geometry.

Ronald Christensen, Ph.D., University of Minnesota, 1983. Bayesian statistics, linear and loglinear models.

Evangelos A. Coutsias, Ph.D., California Institute of Technology, 1979. Nonlinear dynamics, fluid flow.

James A. Ellison, Ph.D., California Institute of Technology, 1970. Dynamical Systems & Stochastic Processes, Beam Dynamics in Modern Colliders & Light Sources, and Particle Channeling in Crystals.

Pedro F. Embid, Ph.D., University of California, Berkeley, 1984. Partial differential equations, applied mathematics.

Frank L. Gilfeather, Ph.D., University of California, Irvine, 1969. High performance computing applications and functional analysis.

Todd M. Kapitula, Ph.D., University of Maryland, 1991. Applied dynamical systems, existence and stability of traveling waves.

Jens Lorenz, Ph.D., University of Muenster, 1975. Numerical analysis, dynamical systems.

Terry A. Loring, Ph.D., University of California, Berkley, 1986. C* Algebras, operator theory.

M. Cristina Pereyra, Ph.D. Yale University, 1993. Harmonic analysis.

Deborah L. Sulsky, Ph.D., New York University, 1982. Scientific computing, fluid and solid dynamics, mathematical biology.

ASSOCIATE PROFESSORS

Gabriel Huerta, Ph.D., Duke University, 1998. Bayesian statistics, time series analysis

Richard Kitchen, Ph.D. University of Wisconsin-Madison, 1996. Mathematics education in the areas of teacher education, equity, and assessment..

Pavel Lushnikov, Ph.D., Landau Institute for Theoretical Physics of the Russian Academy of Sciences, 1997, Topics in applied mathematics, nonlinear waves and theoretical physics.

Michael Nakamaye, Ph.D., Yale University, 1994. Diophantine geometry.

Monika Nitsche, Ph.D., University of Michigan, 1992. Fluid dynamics, applied mathematics, scientific computing.

Santiago R. Simanca, Ph.D., Massachusetts Institute of Technology, 1985. Global Analysis and Partial Differential Equations

Kristin Umland, Ph.D., University of Illinois at Chicago, 1996. Pure mathematics and math education.

ASSISTANT PROFESSORS

Matthew Blair, Ph.D., University of Washington, 2005. Harmonic Analysis and Partial Differential Equations.

Michele Guindani, Ph.D., Universita Commerciale Luigi Bocconi, 2005. Statistics.

Alexander O. Korotkevich, Ph.D., L.D. Landau Institute for Theoretical Physics, 2003. Numerical simulation in general and specifically waves turbulence (mostly ocean waves),

nonlinear waves in different media, optics of metamaterials.

Stephen R. Lau, Ph.D., University of North Carolina, 2004. Scientific computing, spectral methods, general relativity

Yan Lu, Ph.D., Arizona State University, 2007. Survey sampling, nonparametric regression, mixed models and random forests.

Curtis Storlie, Ph.D., Colorado State University, 2005, Statistics

Dimiter Vassilev, Ph.D., Purdue University, 2000. Pure Mathematics.

Wearing, Helen, Ph.D., Heriot-Watt University, 2001. Mathematical modeling and Biology.

Gouyi Zhang, Ph.D., Arizona State University, 2008. Smoothing splines, radial basis functions, and statistical computing.

VISITING FACULTY:

Pavlo Cherepanov, Ph.D., University of New Mexico, 2009. Numerical analysis and multi-scale problems.

Oksana Guba, Ph.D., University of New Mexico, 2008. Differential equations and numerical analysis.

Luis Mata, Ph.D., Bradeis University, 1986. Topology and Geometry

EMERITI:

Reuben Hersh, Ph.D., New York University, 1962

Wojciech Kucharz, Ph.D., University of Katowice, Poland, 1978. Real algebraic geometry.

Ronald M. Schrader, Ph.D., Pennsylvania State University, 1976. Robust statistical methods, quantitative genetics, applied statistics.

Stanly L. Steinberg, Ph.D., Stanford University, 1967. Computer symbol manipulation, numerical grid generation, scientific computing, partial differential equations, applied mathematics.

CORRESPONDENCE AND INFORMATION

Graduate Studies Committee
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University of New Mexico
MSC03 2150
Albuquerque, NM 87131-1141
Telephone: (505) 277-4613
Or visit our web site at: <http://www.math.unm.edu>

WEB PAGES AND RESOURCES

American Mathematical Society

PO Box 5904
Boston, MA 02206-5904
(800) 321-4267 or (401) 455-4000
E-mail: ams@ams.org
Web site: e-MATH: <http://www.ams.org>

American Statistical Association

1429 Duke Street
Alexandria, VA 22314-3402
(703) 684-1221
Web site: <http://www.amstat.org/index.cfm?fuseaction=main>

Association for Women in Mathematics

4114 Computer & Space Sciences Building
University of Maryland
College Park, Maryland 20742-2461
(301) 405-7892
E-mail: awm@math.umd.edu
Web site: <http://www.awm-math.org/>

Institute of Operations Research and the Management Sciences (INFORMS)

901 Elkridge Landing Road, Suite 00
Linthicum, MD 21090-2909
(800) 4IN-FORMS
E-mail: informs@jhuvms.hcf.jhu.edu
Web site: <http://www.informs.org/>

Mathematical Association of America

1529 Eighteenth Street N.W.
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Web site: <http://www.maa.org>

National Council of Teachers of Mathematics

1906 Association Drive
Reston, VA 22091-1593
(703) 620-9840
Web site: <http://www.nctm.org>

Society for Industrial and Applied Mathematics

3600 University City Science Center
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E-mail: siam@siam.org
Web site: <http://www.siam.org/>