Mathematics and Applied Mathematics Graduate Student Handbook

DEPARTMENT OF THEORETICAL AND APPLIED MATHEMATICS
THE UNIVERSITY OF AKRON

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1 Introduction

Welcome to graduate study in Mathematics or Applied Mathematics. The Department of Theoretical and Applied Mathematics at The University of Akron congratulates you on your selection. We hope that your part-time or full-time study with us is beneficial. This handbook has been prepared to aid you in planning your studies here and to guide you through some of the procedures and requirements of the program. It is written in the form of questions and answers, but has no pretense of being complete. If you have any additional questions, please feel free to ask them of your graduate advisor or of any other faculty member.

What programs of study are available in Mathematics or Applied Mathematics?

1. *The M.S. degree program in Mathematics* is designed to give students a solid foundation in graduate–level mathematics, to provide hands–on experience in problem–solving and the uses of technology, and to allow returning mathematics teachers to upgrade their qualifications. The program provides the student with a solid mathematical content background in preparation for governmental or industrial employment or for continued study at the Ph.D. level.

   The program requires 30 credits of graduate coursework, regardless of whether a student chooses the thesis or non–thesis option. In either option, the student carries out independent study or research under the direction of a faculty member. Core requirements include courses in analysis, algebra and statistics or probability.

2. *The M.S. degree program in Applied Mathematics* offers studies in mathematics applied to social sciences, natural science and engineering. This program is designed to give students comprehensive training in analysis as well as applied and computational mathematics. The program provides the student with a solid mathematical content background in preparation for governmental or industrial employment or for continued study at the Ph.D. level.

   This degree program is directed toward students with some background in engineering or the physical sciences. It is appropriate for students interested in the Engineering Applied Mathematics Ph.D. program. Core courses in this program include courses in real analysis, advanced numerical analysis and methods of applied mathematics.

   The M.S. degree requires 30 semester hours of graduate coursework, regardless of whether a student chooses the thesis or non–thesis option. In either option, the student carries out independent study or research under the direction of a faculty member.

3. *The Interdisciplinary Ph.D. program in Engineering Applied Mathematics* is coordinated by faculty of the College of Engineering and the Department of Theoretical and Applied Mathematics. The emphasis of the program is twofold: first, to provide training for students to formulate, analyze and solve contemporary and significant problems in engineering using modern methods of mathematical analysis, and second, to develop students'

interdisciplinary communication skills, thereby enhancing their ability to interact with other professionals.

At least 96 graduate credits are required in the doctoral program, including at least 36 credits of course work, with at least 18 from Engineering and at least 18 from Theoretical and Applied Mathematics. Each student's individual program of research is monitored by the student's Interdisciplinary Doctoral Committee, which is jointly staffed by faculty from the College of Engineering and the Department of Theoretical and Applied Mathematics. This committee advises the student on a formal Plan of Study and other University requirements.

How is Graduate School different from my undergraduate work?

You will concentrate all your studies in your chosen field; there are no "general education requirements." You will spend much more time on each course than you spent on a typical undergraduate course. This time will be divided between careful study of text, notes, and outside sources and preparation of solutions to homework problems. You must take responsibility for learning much material on your own.

What other responsibilities do I have outside of the classroom?

You may have teaching, grading, research, consulting, tutoring or laboratory administration responsibilities. Remember that you are training as a professional in your field, so strive to excel in these activities.

You also have the responsibility for meeting all requirements and deadlines of the Department and the Graduate School as they pertain to your program. Be aware of them and be prompt in meeting them.

In addition, you should make an effort to take an active part in departmental life. You are required to attend Departmental Colloquia and the speaker series.

If you are in the Applied Mathematics program, you should spend time in the Applied Mathematics and Scientific Computation Laboratory, and consider attending the Advanced Seminar in Applied Mathematics (3490:790).

You should make the effort to get to know the faculty and other graduate students; in general, become an active member of the Department. This includes considering participating in the Math club, or the Pi Mu Epsilon mathematics honorary society.

You are responsible for following the University Academic regulations as defined in the Graduate Bulletin.

2 M.S. Degree

What must I do to earn a Master's degree?

1. You must pass the courses in your curriculum with a grade point average of no less than 3.0 (with no more than two grades below B-).
2. You must be advanced to candidacy (see §2.4).
3. You must choose an advisor (and a supervisory committee in the thesis option) and submit a satisfactory Mathematics Seminar paper or a Master's Thesis (see §2.5).
4. The paper or thesis must be presented orally in a public setting. For the non-thesis option, your paper advisor must approve the oral presentation. For the thesis option, your thesis advisor plus one member of your supervisory committee must approve the oral presentation.

2.1 Master's in Mathematics Curriculum

Placement Review: You may be placed in Advanced Calculus I (3450:521) and/or Abstract Algebra I (3450:511) for background work. However, the credits earned for these courses do not count toward the master's degree requirements in mathematics.

Core Requirements: (21–22 credits)	Credits
3450:510 Advanced Linear Algebra	3
or	
3450:513 Theory of Numbers	3
3450:512 Abstract Algebra II	3
3450:522 Advanced Calculus II	3
3450:621 Real Analysis	3
or	
3450:625 Analytic Function Theory	3
3450:636 Advanced Combinatorics and Graph Theory	3
3450:692 Seminar in Mathematics	3
A statistics course, selected from:	
3470:550 Probability	3
3470:551 Theoretical Statistics I	3
3470:561 Applied Statistics I	4
3470:651 Probability and Statistics	4

Thesis Option: (minimum of 30 credits) In addition to the core requirements listed above and any additional requirements determined in the Placement Review, at least six credits in approved electives*, three credits in 3450:699 Thesis Research, and a Thesis must be completed.

<u>Non–Thesis Option:</u> (minimum of 30 credits) In addition to the core requirements listed above, and any other requirements determined by the Placement Review, at least nine credits in approved electives* must be completed. Furthermore, the student must complete a research paper, under the direction of a faculty member in the Department.

* The Mathematics or Applied Mathematics student may take as electives graduate courses from Mathematics (3450), Statistics (3470), or an approved list in Computer Science (3460:518, 535, 557, 570). In addition, any graduate course may be used as an elective, provided that it is approved beforehand by the student's advisory committee. The course (3450:698) Master's Research may not be used to meet degree requirements.

2.2 Master's in Applied Mathematics Curriculum

Placement Review:
You may be placed in Advanced Calculus I, (3450:521), Applied Numerical Methods I (3450:527), Advanced Engineering Mathematics I (3450:538), and one junior–level or above course in Engineering or Physics for background work. The courses (3450:521,527,538) may not be used to meet master's degree requirements in Applied Mathematics.

Core Requirements:	**Credits**
3450:621 Real Analysis	3
3450:627 Advanced Numerical Analysis I	3
3450:633 Methods of Applied Mathematics I	3
3450:692 Seminar in Mathematics	3
Group 1. At least one course from this list must be taken:	
3450:625 Analytic Function Theory	3
3450:628 Advanced Numerical Analysis II	3
3450:632 Advanced Partial Differential Equations	3
Group 2. At least two courses from this list must be taken:	
3450:634 Methods of Applied Mathematics II	3
3450:635 Optimization	3
3450:730 Advanced Numerical Solution of Partial Differential Equations	3

Thesis Option (a minimum of 30 credits) In addition to the placement review and core requirements, at least six credits of electives* approved by the graduate advisor, 3 credits in 3450:699 Master's Thesis, and a Thesis must be completed.

Nonthesis Option (a minimum of 30 credits) In addition to the placement review and core requirements, at least nine credits of electives* approved by the graduate advisor must be completed. Furthermore, the student must complete a research paper, under the direction of a faculty member in the Department.

* The Mathematics or Applied Mathematics student may take as electives graduate courses from Mathematics (3450), Statistics (3470), or an approved list in Computer Science (3460:518, 535, 557, 570). In addition, any graduate course may be used as an elective, provided that it is approved beforehand by the student's advisory committee. The course (3450:698) Master's Research may not be used to meet degree requirements.

2.3 Advisement

Advising is done by a committee of the Graduate Faculty from the Department of Theoretical and Applied Mathematics. Upon your arrival, you will be assigned a temporary advisor who will help you plan your program of study after the Placement Review.

What is the Placement Review interview for Mathematics or Applied Mathematics students?

The Placement Review is the first step in the initial advisement process for Mathematics and Applied Mathematics students. Success in certain undergraduate courses is required for graduate studies in Mathematics or Applied Mathematics. The purpose of this interview is to determine whether or not you have this background. An advisor will attempt to determine your background in the areas listed in §2.1 or §2.2. You may refer to the University Catalog or Departmental syllabi (copies are available in the Departmental office, CAS 220) to see the content of courses under review.

If you have deficiencies in some area, then appropriate courses will be added to the core of your program (with an appropriate increase in the total number of credits required for the degree).

The Placement Review will also determine if any of your previous course work is acceptable for transfer to the University. If you wish to request transfer of graduate credits earned at another university, you should provide a course description from the university's catalog, a course outline or syllabus, and the name of the text(s) used. It would also be very helpful to have a copy of any examinations given.

2.4 Advancement to Candidacy

After completion of half the required credits for the degree, and no later than the semester prior to that of expected graduation, you should request advancement to candidacy for the degree desired. This is done by completing the required Graduate School form, http://www.uakron.edu/gradsch/forms.php.

2.5 Mathematics Seminar and Thesis

What is the Seminar in Mathematics (3450:692)?

The seminar is the individual study of some topic or problem in mathematics by the student under the direction of a member of the Graduate Faculty of the Department. The student selects a faculty advisor under whom he or she will carry out the study and write a research paper or a thesis. In conjunction with that faculty advisor, the student should complete the appropriate paperwork to enroll in 3450:692.

What is required of a research paper?

The research paper should be an exposition of a mathematical topic. It does not need to contain original mathematical results, but it should reflect the student's

understanding and organization of the topic. It should be typed and presented in the appropriate format prescribed by the Graduate School for a thesis, although it is not submitted to the graduate school. It should be approved by the faculty member who agreed to direct the study. Furthermore, the student must present the research paper orally in a public setting. The student's advisor must approve the oral presentation.

What is required of a thesis?

The thesis is a research study of a mathematical topic at a level beyond that of a research paper: Some original contribution is expected. The thesis must be written in accordance with the thesis guidelines of the Graduate School. Earning a master's with thesis requires unanimous acceptance of your thesis by your Thesis Committee. Furthermore, you must present the thesis orally in a public setting. Your advisor plus one member of your Thesis Committee must approve the oral presentation.

When do I sign up for Master's Thesis (3450:699)?

You should allow at least two semesters to complete your work. The decision to pursue a thesis should only be made after consultation with the faculty member under whom you are carrying out the study. In conjunction with that faculty member, you should complete the appropriate paperwork to enroll in 3450:699 and form a Thesis Committee.

Aside from my advisor, who else is on my Thesis Committee?

The thesis committee is composed of three members, at least two of whom must be from the Department of Theoretical and Applied Mathematics. In consultation with your advisor, you should select two other members of the graduate faculty to serve on your committee.

When do I decide to do a research paper or a thesis?

You should talk to the faculty about their research programs and select an advisor no later than the beginning of the semester prior to the one in which you expect to graduate. Be sure to register for 3450:692 at that time.

2.6 Deadlines

2.6.1 Registration for Courses

If you have any questions, see your advisor. There are financial penalties for not meeting certain deadlines. You must consult the appropriate *Schedule of Classes* edition each fall, spring and summer session on the University web page.

2.6.2 Advancement to Candidacy

After completion of half your required courses, you should get the Advancement to Candidacy Form, fill out the top part, and give it to your advisor. Do this no later than the posted University dates. Usually these dates are **close** to September 15 if you expect to graduate in the spring, February 15 if you expect to graduate in the summer, or May 15 if you expect to graduate in the following fall.

2.6.3 Registration for Graduation

The Graduate School and graduation office enforce the deadline very strictly for filing this form. Please see the dates posted by the Graduate School. Usually the dates are **close** to:

1. for December graduation - August 3.
2. for May graduation - January 3.
3. for August graduation - May 3.

2.6.4 Submission of Thesis

Preliminary thesis deadlines are established by the Graduate School and are usually about five weeks before commencement. Final copies (see the Graduate School web page) of the thesis must be delivered to the Graduate School in proper form three weeks before commencement. This means that your advisory committee should have a preliminary copy of your thesis at least one week before the posted graduate school preliminary thesis deadline.

3 Five-Year B.S./M.S. Degree

What is the 5 year B.S./M.S interdisciplinary program?

With five years of study a student will receive, at the same time, a bachelor's degree and a master's degree in mathematics or applied mathematics.

How is this program different from the traditional Bachelor's and Master's programs?

Essentially the student must satisfy the requirements for the traditional Bachelor's and Master's Degrees (see sections 2.1 & 2.2). However, six of the nine required junior or senior level elective credits for the undergraduate program will be replaced by graduate level credits. These six credits will be applied to the elective requirements of both the bachelor's and master's degrees. Further, students in the program may choose to take some of the other undergraduate program elective credits at the graduate level.

When will a student officially become a graduate student?

Once a student is near completion of the core course requirement for the bachelor's degree (usually in the third year of study), he or she will apply for admission into the graduate school to begin graduate level study. Typically, a student in this program will complete the core course sequences of the undergraduate program by the end of the third year. During the fourth and fifth years of study the student will be completing the standard master's program and six elective credits needed for the bachelor's degree. These elective credits will be at the graduate level. Note that those students who have participated in the post-secondary program or taken AP classes before entering The University of Akron may begin their graduate studies earlier.

Are there any special requirements to participate in the program?

The program is well suited for post-secondary students, incoming honors freshmen, and some students directly admitted to Buchtel College for immediate enrollment in the program. Other students and double majors are invited by the faculty to join the program. Since the program is demanding, students will be required to maintain a 3.00 or better GPA. If a student is not able to do this, then he or she will have the option to follow the standard program structure instead of the five-year plan.

4 Ph.D. Degree

4.1 The Interdisciplinary Program

What will take place during the first year as a Ph.D. student?

Upon arrival, you will meet with an initial advisory committee. This committee will conduct a placement review to determine an appropriate initial plan of study, consisting of at most 18 credit hours.

Before completion of the initial plan of study, you must identify an engineering department corresponding to an application area of study, choose a dissertation director, and form an interdisciplinary doctoral committee (IDC). The dissertation director must be a faculty member who is participating in The Engineering Applied Mathematics Program.

You are responsible for obtaining the IDC packet from the College of Engineering web site and processing appropriate forms from that packet as progress is made in the program.

The chair of the IDC must be in your home department or program. The IDC shall consist of six members, with an equal number from the Department of Theoretical and Applied Mathematics and the College of Engineering. College of Engineering committee members must represent at least two departments in Engineering.

How is the Plan of Study determined?

The Plan of Study is established by the IDC, in accordance with the following guidelines:

The Plan of Study has a minimum of 96 credit hours, with a minimum of 36 credit hours of course work at the 600–700 level, none of which come from special topics courses. At least 18 credits of this course work must be from the College of Engineering and at least 18 credits from the Department of Theoretical and Applied Mathematics.

The intent of the course work in the Plan of Study is to provide background necessary to pass the qualifying examinations and for the student to begin the dissertation research. For this reason the Plan of Study should be formulated during the first year of Ph.D. study.

Included in the Plan of Study is a language requirement specified by the IDC.

4.2 The Qualifying Examinations

What are the Qualifying Examinations and when will I take them?

The Qualifying Examinations consist of two components: One component is composed and administered by the Graduate Faculty of the Department of Theoretical and Applied Mathematics under the guidance of the participating faculty from the Department of Theoretical and Applied Mathematics. The second component consists of at least two exams composed and administered by the faculty from one of the departments of the College of Engineering. Some departments from the College of Engineering might require a third exam.

The Qualifying Examinations should be attempted no later than the end of your first year of study, and must be completed by the end of your second year of study. Normally, these Qualifying Examinations will be offered twice per year.

If you fail one or more exams in your first attempt, the Examination Committee will determine which exams are to be retaken. You are required to pass the qualifying exams within two tries.

4.3 The Candidacy Examination

What is the Candidacy Examination and when must it be taken?

The purpose of the Candidacy Examination is to test your ability to conduct independent research.

The Candidacy Examination consists of two components. The first component is a proposal. The IDC Committee will pose a proposal topic related to your research and you will have one month to independently write the proposal in the style of those submitted to the National Science Foundation. The second component is a presentation of that proposal to the IDC Committee.

You must pass the Candidacy Examination within one year after passing the Qualifying Examination. You must pass this exam within two tries.

4.4 The Dissertation Proposal

What happens after one passes the Qualifying Examinations?

You must present an acceptable proposal for Dissertation Research to the IDC within one year after passing the Qualifying Examinations. The proposal shall be in written form, and given to the IDC at least 10 days prior to the scheduled date of the Dissertation Proposal oral presentation.

4.5 The Dissertation

How do I present my dissertation to my IDC and the scientific community?

Your study must be a scientifically acceptable and comprehensive study whose format meets all accepted standards of the College of Engineering and the IDC. The written dissertation should be given to the IDC at least 10 days prior to the scheduled date of the oral defense. You must successfully pass this oral defense with no fail votes from your IDC.

4.6 Further Information

For further information regarding the Ph.D. program, consult the College of Engineering web site.

5 Facilities

5.1 University Library and Computer Center

Most of the mathematical sciences holdings are in the Science and Technology Library and some in Bierce Library. Familiarize yourself with the University's computer system, which lists information about holdings at The University of Akron and other universities. The Library maintains an interlibrary loan service to obtain books and articles which are not locally available.

5.2 Department of Theoretical and Applied Mathematics Facilities

Aside from the University's open computer laboratories, the Department maintains several computational laboratories. There is a wide variety of operating systems, compilers and software packages to facilitate scholarly efforts.

5.3 Applied Mathematics Facilities

Applied Mathematics has its own Research Laboratory, which contains a variety of the latest computational equipment including hardware and software for animation and scientific visualization. There is also access to the Ohio Super-Computer Center located in Columbus, Ohio.