

# Mathematics and Applied Mathematics Graduate Student Handbook

DEPARTMENT OF THEORETICAL AND APPLIED MATHEMATICS  
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Revised

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# 1 Introduction

Welcome to graduate study in Mathematics or Applied Mathematics. The Executive Committee of the Department of Theoretical and Applied Mathematics at The University of Akron congratulates you on your selection. Whether you are a part-time or a full-time student, we hope that your 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 with whom you have contact.

## 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, provide hands-on experience in problem-solving and the uses of technology, and to allow returning mathematics teachers to upgrade their qualifications.

The program requires 30–33 credits of coursework, depending on 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 *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.

The Sciences and Engineering Mathematics 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 Advanced Linear Algebra, Real Analysis, Analytic Function Theory, Advanced Numerical Analysis and Methods of Applied Mathematics.

The M.S. degree requires 30–33 semester hours of graduate course work, depending on 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 an Applied Mathematics 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?**

1. You may have teaching, grading, research, consulting or other outside work responsibilities. Remember that you are in training as a professional in your field, so carry out all of these to the best of your ability.
2. 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.
3. In addition, you should make an effort to take an active part in Departmental life. You are strongly encouraged 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 (3450:790).

Every student 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.

## **2 Academic Matters - MASTER'S DEGREE PROGRAMS**

### **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.
3. You must submit a satisfactory Mathematics Seminar paper or a Master's Thesis.
4. If you choose the non-thesis M.S. option in Applied Mathematics, you must pass the Comprehensive Examinations.

### **2.1 The Curricula**

The curricula are listed below, along with the courses that are covered in the Placement Review for Applied Mathematics students.

## MATHEMATICS

Placement Review: Advanced Calculus I (3450:521) and Abstract Algebra I (3450:511).

<u>Core Requirements:</u> (20–21 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	2

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: (30–39 credits) In addition to the core requirements listed above, and any additional requirements determined in the Placement Review, at least nine credits in approved electives\*, two to four credits in 3450:699 Thesis Research, and a Thesis must be completed.

Non-Thesis Option: (33–42 credits) In addition to the core requirements listed above, and any other requirements determined by the Placement Review, at least twelve 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.

## APPLIED MATHEMATICS

Placement Review: Advanced Calculus I,II (3450:521,522) and one junior-level or above course in Engineering or Physics.

<u>Core Requirements:</u> (23 credits)	Credits
3450:510 Advanced Linear Algebra	3
3450:621 Real Analysis	3
3450:625 Analytic Function Theory	3
3450:627 Advanced Numerical Analysis I	3
3450:628 Advanced Numerical Analysis II	3
3450:633 Methods of Applied Mathematics I	3
3450:634 Methods of Applied Mathematics II	3
3450:692 Seminar in Mathematics	2

Thesis Option: (30–39 credits) In addition to the core requirements listed above, and any additional requirements determined in the Placement Review, three to five credits in approved electives\*, two to four credits in 3450:699 Thesis Research, and a Thesis must be completed.

Non-Thesis Option: (33–42 credits) In addition to the core requirements listed above, and any other requirements determined in the Placement Review, ten credits in approved electives\* must be completed. Furthermore, the student must pass comprehensive examinations in the above underlined courses and complete a research paper.

\* The Mathematics or Applied Mathematics student may take as electives graduate courses in Mathematics (3450), Statistics (3470), or from 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.

## 2.2 Advisement

Advising is done by a committee of the Graduate Faculty from the programs in Mathematics 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?**

1. The Placement Review is the first step in the initial advisement process for Mathematics or Applied Mathematics students. Certain undergraduate background is required for success in 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. You may refer to the University Catalog or Departmental syllabi (copies are available in the Departmental office, Ayer 235) to see the content of courses under review.

2. 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).
3. Another purpose of the Placement Review is to 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.
4. Special attention should be paid to the requirement concerning electives: Any Mathematics (3450 course number), Statistics (3470), and selected Computer Science (3460:518,535,557,570) courses (except those excluded in the catalog) may be used as an elective without prior approval of the student's advisory committee. Any other course must be approved beforehand by the committee, or it will not be accepted for credit.

### **2.3 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 (the appropriate deadline dates will be posted), the student should request advancement to candidacy for the degree desired. This is done by completing the required Graduate School form (this can be obtained in the Department office). If the student has made satisfactory progress toward the degree, then his or her advisor will recommend advancement. Otherwise, the advisor will specify the reasons why advancement should be denied.

### **2.4 Comprehensive Examinations**

(Applied Mathematics Non-Thesis Option)

#### **What is covered on the examinations?**

The core courses covered in the Applied Mathematics Non-Thesis option are: 3450:621,625,627,633, and 634

#### **Who comprises the Examination Committee?**

The Examination Committee is composed of those professors who have recently taught the courses over which the material is to be examined.

#### **When are they given? When do I take mine?**

They are offered at the beginning of Spring semester and of Summer session. Notice of the times of examination will be made early in each semester. The student must notify the advisor in writing of the intention to take the examinations by the deadline included in the notice. Normally, the student may register for the examinations only after advancement to candidacy and after completion of the examination courses. You should

take the examinations as soon as possible after this time. Registration and failure to take the examinations is considered the same as an attempt on the examinations.

#### **What must I do to pass these exams?**

Study! Most students who pass them on the first try spend many weeks preparing for them. You are also encouraged to ask your course instructors for guidance in planning your study.

#### **What happens if I fail a test?**

If you fail one or two tests, then you will be tested during a subsequent examination period over those courses which were failed. If you fail three or more course examinations, then you will be required to take the entire Comprehensive Examinations during a subsequent semester. If you fail any part of this retest, then any request for further examination must be made in writing to the Graduate Faculty of the program that offers the degree, and that committee may offer another test at its discretion.

## **2.5 Mathematics Seminar and Thesis**

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

1. It 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. In conjunction with that faculty advisor, the student should complete the appropriate paperwork to enroll in 3450:692.
2. The principle product of this study is either a research paper or a thesis organized and written by the student.

### **What is required of a research paper?**

It should be an exposition of a mathematical topic. It need not contain original mathematical results, but it should reflect the student's understanding and organization of the topic. It should be typed and presented more or less in the form prescribed by the Graduate School for a Thesis, although it is not submitted as such. It should be approved by the faculty member who agreed to direct the study, and by whoever he or she designates as reader(s).

### **What is required of a thesis?**

It is a research study of some 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. Furthermore, the student must present the thesis in an oral setting to their Thesis Committee. Earning a master's with thesis requires a unanimous pass vote by your Thesis Committee.

### **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, the student 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 which 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 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, you should see your advisor. There are penalties if you don't meet certain deadlines. Registration by phone is possible, but does require you to plan ahead. You must consult the appropriate *Schedule of Classes* edition each Fall, Spring and Summer session, or the University Web Page.

### **2.6.2 Advancement to Candidacy**

After completion of half your required courses, you should get one of these forms from the Department Office, 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 the Comprehensive Examinations**

You will be notified each term of the deadline for registration; normally it is some time near midterm. You should take the exam at your earliest opportunity after advancement to candidacy and completion of the examination courses. It is only required that you have completed the courses when you take the examination, so you may register for the exam even if you are currently enrolled in some of the courses.

### **2.6.4 Registration for Graduation**

The Graduate School and graduation office are very sticky on this deadline. Please see the dates posted by the Graduate School. Usually the dates are close to:

1. for December graduation - May 15 of the previous Spring semester.
2. for May graduation - September 15 of the previous Fall semester.
3. for August graduation - February 15 of the previous Spring semester.

### **2.6.5 Submission of Thesis**

At least two copies of the thesis must be delivered to the Graduate School in proper form three weeks before commencement. This means that the final copy must be passed on by your advisory committee well before this date; one week before allows for unforeseen circumstances.

## **3 Academic Matters - Ph.D. DEGREE**

### **3.1 The Interdisciplinary Program**

#### **What will take place my first year as a Ph.D. Student?**

1. Upon arrival, the student 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.
2. Before completion of the initial plan of study, the student must identify an interdisciplinary field of study, choose a dissertation director, and form an interdisciplinary doctoral committee (IDC).
3. The chair of the IDC must be in the student's home department or program.
4. The IDC shall consist of six members, with an equal number from the Department of Theoretical and Applied Mathematics, and the College of Engineering.

#### **How is my Plan of Study determined?**

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

1. 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, of which none are 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 Mathematics and Computer Science.
2. 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.
3. Included in the Plan of Study is a language requirement specified by the IDC.

### **3.2 The Qualifying Examinations**

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

1. The Qualifying Examinations consist of two components: One component is composed and administered by the Department of Theoretical and Applied Mathematics, and the second component is composed and administered by the faculty from at least one of the departments of the College of Engineering.

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

### **3.3 The Dissertation Proposal**

#### **What happens after I pass the Qualifying Examinations?**

The student must present an acceptable proposal for Dissertation Research to the IDC. This should be done 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.

### **3.4 The Candidacy Examination**

#### **What is the Candidacy Examination and when must I take it?**

1. The purpose of the Candidacy Examination is to test the student's ability to conduct independent research.
2. The student must pass the Candidacy Examination composed and administered by the IDC. This should be done within one year after passing the Qualifying Examination.

### **3.5 The Dissertation**

#### **How do I present my research 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.

### **3.6 Further Information**

For further information regarding the Ph.D. program, consult the documents attached to the end of this handbook.

## **4 Facilities**

### **4.1 University Library and Computer Center**

Most of the Mathematical Sciences holdings are in the Science and Technology Library. We have a fine collection of books. You should 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. There are also a few Mathematical Science holdings in the Bierce Library.

All University of Akron students having a valid registration and identification card can obtain an account for the University's dial-up network through the Computer Center.

### **4.2 Department of Theoretical and Applied Mathematics**

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.

### **4.3 Applied Mathematics facilities**

The Applied Mathematics Division has its own Scientific Computing Laboratory, which contains a variety of the latest computational equipment. Facilities exist for animation and scientific visualization. There is also access to the Ohio SuperComputer Center located in Columbus, Ohio.