Department of Mathematical Sciences
Northern Illinois University
2008-2009

Graduate Programs in the Mathematical Sciences

The Department of Mathematical Sciences offers the Master of Science degree in Mathematics, the Master of Science degree in Applied Probability and Statistics, and the Doctor of Philosophy degree in Mathematical Sciences. The requirements for each degree are described in the latest *Graduate Catalog*. This document is to give you some additional information on our master's program in mathematics and our doctoral program in mathematical sciences. For additional information on the M.S. degree in applied probability and statistics, please contact the Division of Statistics.

M.S. in Mathematics: Students in this degree program choose one of the following four specializations: Applied Mathematics, Computational Mathematics, Mathematics Education, or Pure Mathematics. Our master's program is designed so that students can complete the degree requirements in 2 years of full-time study. Superior full-time students can often fulfill the degree requirements in one academic year, combined with the preceding and following summer terms.

The basic requirements are to complete thirty semester hours (10 3-hour courses) as described in the *Graduate Catalog*, and to pass a written comprehensive examination. With departmental approval, master's students can also complete the degree under the *master's thesis option*. The student prepares a thesis under the direction of the graduate faculty, and gives an oral defense of the thesis. In most cases, three hours of MATH 599 can be applied to the 30 hours required for the master's degree. The oral thesis defense also serves as the student's comprehensive examination, which replaces the written comprehensive examination that is required for master's students in the non-thesis option.

Ph.D. in Mathematical Sciences: Students who enter the doctoral program with a master's degree, or with a very strong undergraduate background, may be able to complete the doctoral program in 4 years of full-time study. This cannot be guaranteed, since it depends crucially on the student's progress in research and in writing a dissertation. Extended time schedules may be designed for part-time students.

Doctoral students focus their work by choosing one of three options for four of their eight required core courses as described in the *Graduate Catalog*. Core group A is for students who will work toward a dissertation in an area of mathematics (pure, applied, or computational), core group B is for students who will pursue research in mathematics education, and core group C is for students who will pursue research in statistics. Note that the degree requirements involve a significant amount of mathematics, regardless of which core group is chosen.

While a high degree of focus and depth is necessary for the preparation of a doctoral dissertation, our doctoral students receive significant breadth of exposure as well. For example, all doctoral students develop a significant application of the computer to their area of research. Doctoral students also complete an Applications Involvement Component (AIC), which is described below. Graduates from our doctoral program obtain a perspective of the mathematical sciences as an integrated whole. The required combination of course work, experience, and research enables a graduate of the program to pursue a career in either academic or non-academic settings.

The Applications Involvement Component in the Ph.D. Program: The design of our doctoral program recognizes the need for new Ph.D. recipients to be exposed to mathematics in non-academic settings by requiring that all doctoral students complete the Applications Involvement Component (AIC) of our Ph.D. degree.

Typically a student's AIC has two parts. In the first, doctoral students attend the AIC colloquia, where speakers external to our department present accounts of how mathematics is used outside of mathematics departments. The external speakers come from industry, government, and education, and are chosen to present a diverse collection of case studies and viewpoints.

The second part of the AIC experience requires each student to undertake an internship in industry, government, or education. Internships usually take place during one of the summers and are arranged by the department's AIC director in consultation with the student. Some of the organizations with which interns have been placed are listed below.

Abbott Research Laboratory
Allied Signal
Ames Research Laboratory
Argonne National Laboratory
AT&T Bell Labs (Murray Hill, New Jersey)
Boeing Computer Services
Cray Research Corporation
DeKalb Genetics
General Electric
General Motors
IBM (Watson Research Center)
Motorola
NASA (Langely)
Numerical Algorithms Group
Oak Ridge National Laboratory
United Aircraft
Wolfram Research
Wright Patterson Air Force Laboratory

Financial support for graduate students: An important difference between undergraduate and graduate study is that quite frequently a university pays graduate students to go to school, not the other way around.

The primary source of support are (a) graduate teaching assistantships; (b) graduate research assistantships; and (c) fellowships. Some 60 of our full-time graduate students are currently supported by one of these means. All of these provide a stipend and a full waiver of tuition. Students are required to pay their own fees (about $500/semester).

Graduate teaching assistants (GTAs). The Department employs about 40 graduate students in this role. A GTA is expected to work about 15 hours/week. A typical assignment would be something like this: In a lower level course (say, college algebra, finite mathematics, or business calculus), a professor would lecture to 240 students 3 times a week. The 240 students are broken down into 8 recitation sections of 30 students each. A GTA will meet with 4 of these recitation sections once a week to answer questions, go over homework problems, give quizzes, etc. The GTA will also hold 3 office hours per week to provide assistance to students. The GTA thus spends 3 hours attending lectures, 4 hours conducting recitation sections, 3 hours meeting students in his/her office, and 5 hours preparing and scoring quizzes, for a total of 15 hours/week.

There are other types of GTA assignments as well. Some GTAs serve as graders for mathematics courses (including some junior and senior level courses). Experienced GTAs are given the opportunity to teach their section of a course (college algebra, trigonometry, or calculus) with full responsibility and an enhanced stipend. Many of our GTAs actively seek this opportunity to develop their skills in teaching and in relating to students in a classroom setting.

Graduate research assistants (GRAs). Almost all members of our faculty are actively engaged in research, and many of them welcome assistance from graduate students in this work. For example, our faculty in mathematics education use GRAs to carry out interviews with children who are learning mathematics, and to transcribe taped records of such interviews. Our faculty in numerical mathematics rely on GRAs to write computer programs for algorithm they are developing, and then to test the programs on actual data. Advanced doctoral students in all parts of the department become full partners in research with their professors, and can sometimes be appointed as GRAs while they work on their dissertations.

Fellowships. Northern Illinois University offers fellowships on a competitive basis to outstanding entering students at the masters level and also to advanced students who are completing their doctoral dissertations. There are several very attractive fellowship programs for minority students as well. Fellowships allow the students to devote full-time to graduate study, since there are no duties connected with them. Typically a fellowship will take 4 courses (12 credit hours), while a GTA will take 3 courses (9 credit hours).

Fellowships awarded in national competitions (e.g., by the Department of Defense or the National Science Foundation) can also be used to support graduate study in NIU.

Level of stipends. For the 2008-2009 academic year, the stipends for full-time GTAs and GRAs range from $1,250/month to $1,600/month for 9 months, depending on the level of experience and the type of assignment which is undertaken. The stipends for fellowships range from $7000 (this may be augmented by a 1/2-time appointment as a teaching assistant) to $14,500 for the academic year. A limited number of summer assistantships are also available on a competitive basis. The stipend for Summer 08 GAs was $1,650.

Doctoral students interested in pursuing research in statistics should contact the Director of the Division of Statistics for information on their policies regarding GTAs and GRAs.

The Transition of Graduate Study. An advantage of our program is that it offers a variety of *transitional courses* to bridge the gap between undergraduate work and graduate-level courses. Working closely with graduate advisers, this allows you to plan the early part of your graduate career in a way that is appropriate for your ability and background. Here is a brief description of some of the transitional courses we offer in various areas. Also refer to the course descriptions given in the *Graduate Catalog*.

(A) Algebra. If you have already had one-year sequence of courses in abstract algebra (proof-oriented courses on groups, rings, and fields), then you are probably ready for the initial graduate algebra sequence, MATH 620 and 621. If not, then you may want to start with MATH 520 and 521, transitional courses which discuss groups, rings, and fields, and allow you to develop your skills at writing correct proofs. There is another transitional course, MATH 523, a second course in linear algebra. Perhaps your first linear algebra course was taken as a sophomore and focused on matrix theory. The second course is more theoretical, and provides important background for subsequent graduate courses in virtually all areas of mathematics.

(B) Analysis. If you have already had a one-year sequence of courses in advanced calculus (including differentiation and integration of functions of several variables), with lots of attention paid to writing your own proofs, then you are probably ready for the initial graduate analysis courses, MATH 630 and MATH 632. If not, then you may want to start with MATH 530 and 531, transitional courses in advanced calculus which will give you lots of practice at writing proofs, as well as exposure to the important techniques of the area. MATH 432 (Advanced Calculus III) also fits in this category; it is intended as preparation for MATH 642 (Partial Differential Equations).

(C) Differential Equations. You have probably had one course in differential equations as an undergraduate, perhaps with a primary focus on techniques. If not, you should consider taking the NIU course MATH 336. This is a sub-transitional course (an undergraduate course) and would not carry graduate credit. The initial graduate courses are MATH 636 (ordinary differential equations) and MATH 642 (partial differential equations). Before taking MATH 642, it is recommended that you have appropriate background in line integrals, surface integrals, and Fourier series. This is provided by another transitional course, MATH 532 (Advanced Calculus III).

(D) Mathematics Education. Graduate students who are also seeking certification to teach at the middle and secondary school level, in addition to a graduate degree, can be accommodated through courses in methods of teaching (MATH 410 and MATH 412) and the student teaching experience. However, these courses do not carry credit for graduate degrees in mathematical sciences.

(E) Numerical Analysis. If you have never written and debugged your own programs in a high-level programming language such a FORTRAN or C, you may wish to take a programming class such as Computer Science 230, which is sub-transitional and does not carry graduate credit, before taking your first numerical analysis class. However, graduate mathematics students who have some programming experience will receive little benefit by taking this course.

Our introductory numerical analysis courses are MATH 534 (numerical linear algebra), MATH 535 (A survey of approximation techniques, numerical integration, and numerical solution of differential equations), and MATH 662 (numerical analysis). These courses involve programming in FORTRAN (or 'C'), and they provide and introduction to theoretical issues in numerical analysis.

MATH 662 is an introductory numerical analysis class, and is required for all doctoral students. This course covers many of the same topics as MATH 534 and MATH 535, but from a more advanced mathematical perspective. Doctoral students who desire a transition to MATH 662 can take MATH 534 or MATH 535, but not both of these. (Students may receive credit for only two of MATH 534, MATH 535, and MATH 662). After completing MATH 662, or MATH 534 and MATH 535, students are ready to take subsequent graduate courses in numerical analysis: MATH 664 (numerical linear algebra), and MATH 666 (numerical differential equations).

In the related area of optimization theory, the course MATH 444 (linear programming) is sub-transitional, and does not carry graduate credit. The first graduate course in this area is MATH 668 (nonlinear programming).

(F) Topology. The transitional course is MATH 550, which should be taken after a theoretical course in advanced calculus (such ad MATH 530). MATH 550 is almost entirely a course in point-set topology. The initial graduate course in MATH 650, which discusses algebraic as well as point-set topology. MATH 521 is also a prerequisite for MATH 650. Because of the algebraic nature of MATH 650, students may benefit by also taking MATH 620 before taking MATH 650.

The transitional courses described above can be very helpful in facilitating a smooth entry into our program. Keep in mind, however, that a decision to begin at the transitional level will probably delay the completion of your program. If your background has prepared you for the basic graduate courses (this is something your adviser can help you to measure), then you should go ahead and take them.

Examples of Programs of Study. The following pages provide examples of programs of study in the 4 specializations for the M.S. in mathematics (10 courses, 30 hours) and the Ph.D. in mathematical sciences (90 hours). **Many other combinations of courses are possible**. Your adviser will have up-to-date information on the semesters when particular courses are normally offered.

For additional information on our M.S. program in mathematics, our Ph.D. program in mathematical sciences, and financial support for students in these degree programs, please contact

Professor Bernard Harris
Director of Graduate Studies
Northern Illinois University
DeKalb, IL 60115

phone number: (815) 753-6775 email: *gradprog@math.niu.edu*

or visit our web page at *http://www.math.niu.edu/programs/grad/*.

Students interested in doing graduate work in statistics should contact the Division of Statistics for information about their program. The Division of Statistics also has its own budget for graduate assistantships; contact the Director of the Division for details.

Notes for sample master's programs (Items I-IV):

(*) Both MATH 520 and MATH 530 carry graduate credit, but only one of them may be counted toward a graduate degree in mathematics. Also, Computer Science 230 does not count toward the graduate program.

(**) With the consent of the department, master's students have the option of writing a master's thesis, instead of passing a written comprehensive examination. The thesis is prepared under the direction of a member of the graduate faculty, and is defended during an oral comprehensive examination. In most cases the thesis experience leads to three hours of credit in MATH 699, which can be applied to the 30 hours required for the master's degree.

I. M.S. in Mathematics: Applied Mathematics Specialization

	Average Background		Strong Background
Fall 2009	Math 520* Algebra I	Fall 2009	Math 630 Real Analysis I
	Math 530* Advanced Calculus I		Math 636 Ordinary Differential Equations I
	Computer Science 230* FORTRAN		Math 662 Numerical Analysis
SP 2010	Math 523 Linear & Multilinear Algebra	SP 2010	Math 523 Linear & Multilinear Algebra
	Math 531 Advanced Calculus II		Math 632 Complex Analysis
	Elective		Math 642 Partial Differential Equations I
SU 2010	Math 532 Advanced Calculus II		
Fall 2010	Math 630 Real Analysis I	Fall 2010	Math 620 Algebraic Structures I
	Math 636 Ordinary Differential Equations I		Math 631 Functional Analysis
	Math 662 Numerical Analysis		Math 640 Applied Mathematics
SP 2010	Math 632 Complex Analysis	SP 2010	Electives (621, 664, 666, 684, or 700 level)
	Math 642 Partial Differential Equations (or Math 542 Elements of Partial Differential Equations)		
	Elective (664, 666, or 684)		

June 2010--M.S. Written Comprehensive Examination over Analysis and Differential Equations**

II. M.S. in Mathematics: Computational Mathematics Specialization

	Average Background		Strong Background
Fall 2009	Math 520* Algebra I	Fall 2009	Math 630 Real Analysis I
	Math 530* Advanced Calculus I		Math 662 Numerical Analysis
	Math 534 Numerical Linear Algebra		Math 668 Nonlinear Programming
SP 2010	Math 523 Linear & Multilinear Algebra	SP 2010	Math 523 Linear & Multilinear Algebra
	Math 531 Advanced Calculus II		Math 664 Numerical Linear Algebra
	Math 535 Numerical Analysis		Math 666 Numerical Differential Equations
Fall 2010	Math 630 Real Analysis I	Fall 2010	Math 631 Functional Analysis
	Math 636 Ordinary Differential Equations I		Math 636 Ordinary Differential Equations I
	Math 668 Nonlinear Programming		Elective
SP 2010	Math 664 Numerical Linear Algebra	SP 2010	Math 632 Complex Analysis
	Math 666 Numerical Differential Equations		Elective
	Elective		Elective

June 2010--M.S. Written Comprehensive Examination over Analysis and Numerical Mathematics**

III. M.S. in Mathematics: Mathematics Education Specialization The sequences below are suggested for full-time graduate students. Part-time graduate students should consult with an adviser for an appropriate schedule.

	Average Background		Strong Background
Fall 2009	Math 520* Algebra I Math 530* Advanced Calculus I Math 610 Theoretical Foundations of Mathematics Education	Fall 2009	Math 610 Theoretical Foundations of Mathematics Education Math 613 Teaching of Algebra Math 620 Algebraic Structures I
SP 2010	Math 521 Algebra II Math 531 Advanced Calculus II Math 614 Teaching of Geometry	SP 2010	Math 523 Linear & Multilinear Algebra Math 531 Advanced Calculus II Math 614 Teaching of Geometry
		SU 2010	Math 550 Introduction to Topology
Fall 2010	Math 580 Number Theory Math 613 Teaching of Algebra Math 620 Algebraic Structures I (or Math 630 Real Analysis I)	Fall 2010	Stat 573/573A Statistical Methods & Models I Math 630 Real Analysis I Graduate course in a related discipline such as education, psychology... with consent of the adviser.
SP 2010	Stat 573/573A Statistical Methods & Models I (or Math 632 Complex Analysis) Math 611 Introduction to Mathematics Education Research (or Math 615, Using Microcomputers in Teaching Mathematics) Graduate course in a related discipline such as education, psychology... with consent of the adviser.	SP 2010	Math 611 Introduction to Mathematics Education Research Math 632 Complex Analysis (or Math 615, Using Microcomputers in Teaching Mathematics) Graduate course in a related discipline such as education, psychology... with consent of the adviser.

June 2010--M.S. Written Comprehensive Examination over Algebra (or Analysis) & Mathematics Education**

IV. M.S. in Mathematics: Pure Mathematics Specialization

	Average Background		Strong Background
Fall 2009	Math 520* Algebra I	Fall 2009	Math 620 Algebraic Structures I
	Math 530* Advanced Calculus I		Math 630 Real Analysis I
	Math 534 Numerical Linear Algebra		Math 636 Ordinary Differential Equations I
SP 2010	Math 521 Algebra	SP 2010	Math 621 Algebraic Structures II
	Math 523 Linear & Multilinear Algebra		Math 632 Complex Analysis
	Math 531 Advanced Calculus II		Math 650 Topology
SU 2010	Math 550 Introduction to Topology		
Fall 2010	Math 620 Algebraic Structures I	Fall 2010	Math 631 Functional Analysis
	Math 630 Real Analysis I		Math 662 Numerical Analysis
	Math 636 Ordinary Differential Equations I		Elective
	Math 668 Nonlinear Programming		
SP 2010	Math 535 Numerical Analysis	SP 2010	Elective
	Math 632 Complex Analysis		Elective
	Math 650 Topology or		Elective
	Math 621 Algebraic Structures II		

June 2010--M.S. Written Comprehensive Examination over Analysis and Analysis**

V. Ph.D. degree in Mathematical Sciences: Core Group A (Mathematics) Pure Mathematics or Applied Mathematics Focus

(This 4-year program assumes a strong entering background, including a one-year sequence in probability and statistics. If the entering background is average, add one year and one summer at the outset for Math 520, 521, 530, 531, 534, 542 and 550, and Stat 570 and 572 as necessary). Doctoral students should register for one hour of Math 792 each Fall and Spring semester that they are in residence on campus, before the working phase of their AIC (Spring of the 3rd year in this example).

Fall 2009	Math 620 Algebraic Structures I
	Math 630 Real Analysis I
	* Math 636 Ordinary Differential Equations I
Spring 2009	* Math 621 Algebraic Structures II
	Math 632 Complex Analysis
	* Math 650 Topology
Summer 2010	Foreign Language Reading Course or Math 532 Advanced Calculus III (or other elective)

Fall 2010	* Math 631 Real Analysis II (Functional analysis)
	Math 640 Applied Mathematics (or other elective)
	Math 662 Numerical Analysis
January 2011	**WRITTEN PH.D. QUALIFYING EXAMINATION**
or June 2011	
Spring 2011	* Math 642 Partial Differential Equations I
	600-level elective
	700-level seminar
Summer 2011	700-level reading course

Fall 2011	600-level elective
	700-level seminar or reading course
	700-level seminar or reading course
Spring 2012	Applications Involvement Component (internship)
	700-level seminar or reading course
	Math 799 Doctoral Research and Dissertation
Summer 2012	**ORAL PH.D. CANDIDACY EXAMINATION**
	Computer project
	700-level seminar or reading course
	Math 799 Doctoral Research and Dissertation

Fall 2012	700-level seminar or reading course
	Math 799 Doctoral Research and Dissertation
Spring 2013	Math 799 Doctoral Research and Dissertation
Summer 2013	Math 799 Doctoral Research and Dissertation
	COMPLETE DISSERTATION AND GRADUATE

***The program requires 4 of these 5 courses.**

VI. Ph.D. degree in Mathematical Sciences: Core Group A (Mathematics) Computational Mathematics Focus

(This 4-year program assumes a strong entering background, including a one-year sequence in probability and statistics. If the entering background is average, add one year and one summer at the outset for Math 520, 521, 530, 531, 534, 542 and 550, and Stat 570 and 572 as necessary). Doctoral students should register for one hour of Math 792 each Fall and Spring semester that they are in residence on campus, before the working phase of their AIC (Spring of the 3rd year in this example).

Fall 2009	Math 620 Algebraic Structures I
	Math 630 Real Analysis I
	Math 662 Numerical Analysis
Spring 2010	* Math 621 Algebraic Structures II
	Math 632 Complex Analysis
	Math 664 Numerical Linear Algebra
Summer 2010	Foreign Language Reading Course
June 2010 or	
June 2011	**WRITTEN PH.D. QUALIFYING EXAMINATION**

Fall 2010	* Math 631 Real Analysis II (Functional analysis)
	* Math 636 Ordinary Differential Equations
	Math 668 Nonlinear Programming
Spring 2011	Math 666 Numerical Differential Equations
	* Math 642 Partial Differential Equations I
	* Math 650 Topology
Summer 2011	700-level reading course

Fall 2011	Math 640 Applied Mathematics (or other elective)
	700-level seminar or reading course
	700-level seminar or reading course
Spring 2012	Applications Involvement Component (internship)
	700-level seminar or reading course
Summer 2012	**ORAL PH.D. CANDIDACY EXAMINATION**
	Computer project
	700-level seminar or reading course
	Math 799 Doctoral Research and Dissertation

Fall 2012	700-level seminar or reading course
	Math 799 Doctoral Research and Dissertation
Spring 2013	Math 799 Doctoral Research and Dissertation
Summer 2013	Math 799 Doctoral Research and Dissertation
	COMPLETE DISSERTATION AND GRADUATE

***The program requires 4 of these 5 courses.**

VII. Ph.D. degree in Mathematical Sciences: Core Group B (Mathematics Education)

A typical 4-year schedule for this degree is given below. Special schedules may be designed to fit the needs of part-time or other students. Doctoral students should register for one hour of Math 792 each Fall and Spring semester that they are in residence on campus, before the working phase of their AIC (Fall of the 3rd year in this example).

Fall 2009	Math 610 Theoretical Foundations of Mathematics Education
	Math 520* Algebra I
	Math 530* Advanced Calculus I
Spring 2010	Math 614 The Teaching of Geometry
	Math 521 Algebra II
	Math 531 Advanced Calculus II
Summer 2010	Math 612 The Teaching of Mathematics, Grades 6-9
	Prepare for Foreign Language Reading Exam

Fall 2010	Math 613 The Teaching of Algebra
	Math 620 Algebraic Structures I
	Math 630 Real Analysis I or Math 662 Numerical Analysis
Spring 2011	Math 611 Introduction to Mathematics Education Research
	Math 615 Using Microcomputers in Teaching Mathematics
	Math 632 Complex Analysis
Summer 2011	Math 710A or B Topics in Mathematics Education
June 2011	**WRITTEN PH.D. QUALIFYING EXAMINATION**

Fall 2011	Initiate Applications Involvement Component
	Math 662 Numerical Analysis or Math 630 Real Analysis I
	Elective topics course or seminar outside mathematics education
Spring 2012	Math 710A or B Topics in Mathematics Education
	Elective topics course or seminar outside mathematics education
	ORAL PH.D. CANDIDACY EXAMINATION
Summer 2012	Math 799 Doctoral Research and Dissertation
	Computer project
	Applications Involvement Component completed

Fall 2012	700-level elective topics course or seminar
	Math 710A or B Topics in Mathematics Education
	Math 799 Doctoral Research and Dissertation
Spring 2013	Math 710A or B Topics in Mathematics Education
	Math 799 Doctoral Research and Dissertation
Summer 2013	Math 799 Doctoral Research and Dissertation
	COMPLETE DISSERTATION AND GRADUATE

***MATH 520 and MATH 530 both carry graduate credit, but only one of these two courses may be counted toward a mathematical sciences graduate degree.**