Department of Mathematical Sciences

# Graduate Student Handbook

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Michigan Technological University
Department of Mathematical Sciences

# Graduate Student Handbook

## 1 Introduction

Thank you for your interest in the Department of Mathematical Sciences at Michigan Tech. This is an excellent place to pursue a graduate degree in mathematics or statistics, as we have an enthusiastic faculty pursuing a variety of interesting research projects.

Ours is a dynamic department striving to be on the cutting-edge of the mathematical sciences. Several recent changes illustrate this:

- We have added faculty members in important areas of research, such as fluid dynamics and bioinformatics.
- We have updated our course offerings, adding new courses of immediate interest to students and deleting courses of lesser impact.
- We have instituted a comprehensive graduate teaching assistant (GTA) training program. Most of our students receive financial aid as GTAs. One of the best ways to learn mathematics is to teach it, so acting as a GTA can be an important part of your program of study. We are improving our training and support of GTAs to make their experience even more rewarding.

You have a tremendous opportunity to spend the next 2-5 years studying and laying the foundation for a career in the mathematical sciences. This handbook explains the application process and our degree requirements, describes our department and its faculty, and introduces you to the university. Please contact us (mathdept@mtu.edu, (906) 487-2068) if you have further questions.

# 2 The Application Process

Upon receipt of your initial letter of inquiry, an application packet will be sent to you, including the following information:

- ⋆ The Graduate Student Handbook (this document)
- ⋆ an application form
- ⋆ three forms for letters of recommendation

Please read all of the enclosed information carefully.
Following are the steps to apply for admission to our department.

- ⋆ Material to send to the Graduate School
  *Send the following materials to*

  The Graduate School
  Michigan Technological University
  1400 Townsend Drive
  Houghton, Michigan 49931–1295

  *by February 15*

  1. The completed application form. The application form can be completed on-line at http://www.mtu.edu/apply. If you choose to apply on-line, you must download, sign, and mail the signature page of the application.
  2. A statement of purpose. Special attention should be given to your statement; well-motivated students have a better chance of being admitted with support.
  3. Official transcripts from all colleges or universities you have attended.
  4. Official test scores. Do not send copies.
     - General GRE test(all applicants)
     - TOEFL (Test of English as a Foreign Language) (all foreign applicants whose native language is not English).
- ⋆ Materials sent directly to the Department of Mathematical Sciences
  1. The Department of Mathematical Sciences requires three (3) letters of recommendation which should be received in the department by February 15. Select three individuals (preferably professors) to use the enclosed forms to prepare recommendations for you. The recommendations should be submitted by the recommender directly to:

     Director of Graduate Studies
     Department of Mathematical Sciences
     Michigan Technological University
     1400 Townsend Drive
     Houghton, Michigan 49931–1295
     Telephone: (906) 487–2068
     E–mail: mathdept@math.mtu.edu
     FAX: (906) 487–3133

Letters of recommendation must be sent directly to the Director of Graduate Studies in the Math Department, not to the Graduate School.

Letters of recommendation must be mailed by the recommenders; you may not mail them yourself.

All material must be received by the Graduate School or the Department of Mathematical Sciences by 15 February to ensure consideration.

# 3 The Review Process

The evaluation of applications by the Graduate Committee begins shortly after the application deadline. The Graduate Committee determines whom to admit to the graduate program based on academic qualifications, GRE and TOEFL scores, letters of recommendation, and the statement of purpose. Prior research or teaching experience also strengthens an application.

**Financial Support:** Applicants are automatically considered for financial support. All supported students receive a full ride (tuition and stipend) in the form of a Graduate Teaching Assistantship or a Graduate Research Assistantship.

- **Graduate Teaching Assistants** (GTAs) act as classroom or lab instructors. Classroom instructors teach pre-calculus, calculus, and sometimes more advanced subjects independently, while lab instructors lead computer labs in which the students use sophisticated computer algebra software in conjunction with calculus courses. In either role, GTAs gain experience that is useful in many careers.

  The department has one of the most thorough GTA training programs in the nation, including:

  1. a course on teaching college mathematics for classroom instructors;
  2. a course on computer algebra for lab instructors;
  3. a teaching seminar;
  4. an established mentoring program for all new GTAs.

  *A good command of spoken English is required for a student to be supported as a teaching assistant.*

- **Graduate Research Assistants** (GRAs) assist faculty members who have research projects funded by industry or an agency such as the National Science Foundation, the Department of Energy, etc. Typically, the research performed by a GRA will form a part of his or her thesis.

# 4 Master of Science Degree

The MS degree in the Mathematical Sciences is offered in

Applied Mathematics
Discrete Mathematics
Pure Mathematics
Statistics

and can be obtained under three plans:

**Plan A, Thesis Option**

- 21–24 credits of course work;
- 6–9 credits of thesis research (30 credits total);
- a written thesis describing original research.

**Plan B, Report Option**

- 24–27 credits of course work;
- 3–6 credits of research report (30 credits total);
- a written report describing the results of research project.

**Plan C, Course Work Option**

- 30 credits of course work;
- a proficiency examination.

Most students take two years to finish an MS degree.

**MS Thesis:** Under Plan A, the thesis option, a student must write a thesis reporting on original research conducted under the guidance of a faculty adviser. This research normally represents about one semester of full-time work (9 research credits), although it may be spread out over several semesters. The student must also present a successful oral defense of the thesis.

Normally a thesis will result in a published journal article (typically submitted after the MS is earned). The publishable quality of the research is the distinguishing characteristic of the thesis option (as opposed to the report option).

**MS Report:** Under Plan B, the report option, a student must write a report reporting on an investigation conducted under the guidance of a faculty adviser. The student must also present a successful oral defense of the report.

The content of the report and the work it represents can vary considerably. Some possibilities are:

1. The student completes a significant programming project in support of a faculty member's research.

2. The student investigates a topic in detail and presents a high-quality exposition of some aspect of it.

3. The student does some preliminary, original research on a topic, together with a literature review of known results.

**Course Work:** Under Plan C, the course work option, the students must take the Proficiency Examination (see Section 5). The proficiency exam is described in detail here:

http://www.math.mtu.edu/graduate/prof/

Students also must take 6–7 core courses in their area of concentration. These courses make up 18–21 credits of the required 30. Although these courses are required, substitutions are granted in exceptional cases. No more than 12 credits of undergraduate courses are allowed to count toward the Master's degree. Typically, undergraduate classes are taken by students who need to fill in gaps in their backgrounds. All supported graduate students must enroll for 9 credits (three courses) each semester. At most four credits per academic year may be taken outside the department. Exceptions must be approved by the Director of Graduate Studies.

Following are the required core classes for the Master's degree in each of the four areas:

## 4.1 Applied Mathematics Core

| SUBJECT | COURSE | CREDITS |
|---|---|---|
| Numerical Linear Algebra | MA5627 | 3 |
| *and any two of the following sequences:* | | |
| Real Analysis | MA5401 | 3 |
| Functional Analysis | MA5524 | 3 |
| Numerical ODEs | MA5628 | 3 |
| Ordinary Differential Equations | MA5510 | 3 |
| Numerical PDEs | MA5629 | 3 |
| Partial Differential Equations | MA5565 | 3 |
| Discrete Optimization | MA5211 | 3 |
| Numerical Optimization | MA5630 | 3 |
| *and any two courses from the previous or following list:* | | |
| Complex Variables | MA5405 | 3 |
| Mathematical Modeling I | MA5504 | 3 |
| Asymptotic & Perturbation Methods | MA5531 | 3 |
| Applied Integral Equations | MA5545 | 3 |
| Continuum Mechanics | MA5548 | 3 |
| Computational Fluid Dynamics | MA5640 | 3 |

## 4.2 Discrete Mathematics Core

| SUBJECT | COURSE | CREDITS |
|---|---|---|
| Finite Groups and Fields | MA5301 | 3 |
| Graph Theory | MA5221 | 3 |
| Design Theory | MA5222 | 3 |
| Error-Correcting Codes | MA5231 | 3 |
| *and any two of the following courses:* | | |
| Combinatorial Algorithms | MA5201 | 3 |
| Rings and Modules | MA5302 | 3 |
| Cryptography | MA5232 | 3 |
| Discrete Optimization | MA5211 | 3 |
| Finite Geometry | MA6201 | 3 |
| Permutation Groups and Enumerate | MA6301 | 3 |
| Algebraic Curves and Codes | MA6302 | 3 |

## 4.3 Pure Mathematics Core

| SUBJECT | COURSE | CREDITS |
|---|---|---|
| Graph Theory | MA5221 | 3 |
| Finite Groups and Fields | MA5301 | 3 |
| Real Analysis | MA5401 | 3 |
| *and one of the following courses:* | | |
| Ordinary Differential Equations | MA5510 | 3 |
| Partial Differential Equations | MA5565 | 3 |
| *and any three of the following courses:* | | |
| Rings and Modules | MA5302 | 3 |
| Design Theory | MA5222 | 3 |
| Error-Correcting Codes | MA5231 | 3 |
| Finite Geometry | MA6201 | 3 |
| Algebraic Curves and Codes | MA6302 | 3 |
| Functional Analysis | MA5524 | 3 |
| Ordinary Differential Equations | MA5510 | 3 |
| Partial Differential Equations | MA5565 | 3 |

### 4.4 Statistics Core

| SUBJECT | COURSE | CREDITS |
|---|---|---|
| Mathematical Statistics I | MA5711 | 3 |
| Mathematical Statistics II | MA5712 | 3 |
| Linear Models | MA5731 | 3 |
| Categorical Data Analysis | MA5791 | 3 |
| Computational Statistics | MA5761 | 3 |

*Students can fill out their course requirements with other graduate level statistics courses that are offered on demand:*

| SUBJECT | COURSE | CREDITS |
|---|---|---|
| Statistical Genetics | MA5750 | 3 |
| Sampling | MA5740 | 3 |
| Survival Analysis | MA57XX | 3 |
| Multivariate Analysis | MA4750 | 3 |

BACKGROUND COURSES

Students should take Statistical Methods (MA5701), Regression Analysis (MA4710), Experimental Design (MA4720), Undergraduate Mathematical Statistics I and II (MA4760 and MA4770) in their first year of study if they have not taken these or similar courses. See the Director of Graduate Studies if you have questions.

# 5 The Doctor of Philosophy Degree

The Doctoral degree is offered in three areas of concentration

- Applied Mathematics
- Discrete Mathematics
- Statistics

Below the requirements for earning the PhD are discussed.

**Proficiency Examination:** Each PhD student must pass the proficiency examination for his or her area of concentration within 1.5 years of entering the program. The proficiency examination covers undergraduate material and ensures that the student has the necessary background and ability to pursue the PhD degree. It is not uncommon for an entering student to take one or two undergraduate (4000-level) courses to prepare for the proficiency examination. If this is necessary, these courses should be taken during the first semester.

The proficiency examination is given twice a year during the week before the Fall semester starts and the week before the Spring semester starts. It is described in detail here:

http://www.math.mtu.edu/graduate/prof/

**Coursework and Credits:** Students with a recognized MS degree must earn 30 credits in graduate courses (5000-level and above); a student entering without an MS degree must earn 60 credits, of which 12 can be in undergraduate courses (4000-level) and the remainder must be in graduate courses. Dissertation research credits count toward these totals.

Each student must complete the coursework required for the MS in his or her area of concentration. (For a student entering with an MS from another university, equivalent courses taken for the MS can fulfill part or all of this requirement.)

Each student must complete 9 credits in graduate mathematics courses outside his or her area of concentration. (For example, a discrete mathematics student will take courses in applied mathematics or statistics to fulfill this requirement.) This requirement is referred to as the *breadth requirement*. Only courses taken at Michigan Tech can fulfill this requirement.

**Comprehensive examination:** Each student must pass a comprehensive examination that covers graduate coursework. The examination consists of two tests over standard topics (chosen from a short list) and a specialized test over the student's particular research area. The comprehensive examination must be passed within five years of entering the program.

The comprehensive examination given twice a year during the week before the Fall semester starts and the week before the Spring semester starts. It is described in detail here:

http://www.math.mtu.edu/graduate/comp/

**Dissertation and Defense:** Each student is required to write a doctoral dissertation and present a successful oral defense of the dissertation. The dissertation must describe the results of original research and will normally result in one or more published journal articles (which may, however, be submitted after the PhD is earned).

The dissertation typically requires one to two years of (full-time) research, and is the most important part of the student's program of study.

**Internship:** Each student is encouraged to spend one or two terms as an industrial or government intern or to be actively involved in an industrially-sponsored research project. These can be arranged individually or in consultation with the student's adviser.

**Advisory Committee:** Each student, in consultation with the Director of Graduate Studies, will select an advisory committee during his or her first semester of study. The committee, which consists of three members of the graduate faculty from the Department of Mathematical Sciences, helps the student to plan a program of study leading to the PhD degree. In particular, the student and committee must create a tentative schedule of courses that prepares the student for the proficiency examination, the comprehensive examination, and dissertation research.

Each student must find a research adviser who will guide the student's dissertation research. Ideally, this adviser will serve on the student's advisory committee; however, the advisory committee must be selected during the student's first semester, and in many cases the student will not have settled on a research adviser at that point.

The choice of research adviser is undoubtedly the student's most important decision, since the student will work closely with this faculty member for several years. The choice must be mutual—that is, the student and the adviser must choose each other.

# 6 Housing

The University maintains residence hall accommodations as well as the Daniell Heights apartment complex. During the 2007-08 academic year, the Daniell Heights apartment offer the following room rental schedule for family, college seniors, and graduate students; $459 per month for one bedroom, $511 for two bedrooms, and $662 for three bedrooms. For additional rates and other room types available, please contact the office of Residential services (for dorm rooms) or Daniell Heights (for apartments). Off-campus apartments and rooms are available and are generally considered to be inexpensive when compared with the rest of the nation and on-campus housing. Other costs of living are generally low to moderate.

# 7 Computing and Library Facilities

The Department of Mathematical Sciences has a computer lab consisting of a grid of more than 70 Linux computers and a windows application server. Faculty and graduate student offices also contain a variety of computers including Linux computers, Sun Workstations, and PCs. Students and faculty use this technology in many ways. For example:

- *Mathematica* is used for symbolic manipulation and graphics in calculus and differential equations courses and for examining special cases of theoretical conjectures.
- SAS is a powerful statistical package used for both research and coursework.
- TeX and LaTeX are used for preparing research papers.
- Openoffice, Word, and Excel are used by students for their word processing and spreadsheet needs.
- E-mail and the web are used by everyone.

The Michigan Tech Library contains 710,000 volumes and subscribes to 12,000 serials and periodicals, many in the mathematical sciences and related areas. The library has open stacks, microfilm, graduate student and faculty carrels, inter-library loan privileges, photocopying facilities, and computerized bibliographic search services.

# 8 About the University

Michigan Technological University was founded in 1885 as the Michigan School of Mines and currently enrolls 6200 undergraduate and graduate students, predominantly in engineering and science. This concentration of purpose allows these programs at MTU to compare favorably with those at general universities five times as large.

Ranking among the top twelve U.S. universities in terms of undergraduate engineering enrollment, Michigan Tech also offers strong programs in computer science, physics, forestry, biology, chemistry and business—as well as in mathematics. Michigan Tech has an excellent

reputation in engineering and science education at both the undergraduate and graduate levels and excels in research within several spheres of science and technology.

The University is located in Houghton, Michigan. Proximity to Lake Superior provides moderate summer temperatures and snowy winters averaging 200 inches per year. Autumn and spring are cool and colorful. The remoteness imposed by geography is mitigated by the beauty of the countryside, which is relatively unspoiled and free of pollution. There are abundant opportunities for outdoor recreational activities during all seasons. The University operates an indoor ice arena, an eighteen-hole golf course, 8 kilometers of Nordic ski trails, its own ski hill with a chair lift, and an indoor tennis center. Cultural attractions are sponsored by the University and the surrounding communities. Houghton is served by Northwest Airlines.

# 9 The Faculty and Their Research

John P. Beckwith
Associate Professor
PhD, Wayne State University
*Statistics*

Juergen Bierbrauer
Professor
PhD, Mainz University, Germany
*Combinatorics, cryptology, algebra*

Huann-Sheng Chen
Associate Professor
PhD, University of Illinois at Urbana-Champaign
*Statistical genetics, survival data analysis, applied and computational statistics*

Jianping Dong
Professor and Director of Graduate Studies
PhD, New York University
*Statistical genetics, categorical data analysis, nonparametric smoothing*

Thomas D. Drummer
Professor
PhD, University of Wyoming
*Statistical ecology, model–based sampling, applications of statistics to wildlife management*

Lee Erlebach
Associate Professor
PhD, University of Washington
*2–Person game theory*

Kathleen A. Feigl
Professor
PhD, Illinois Institute of Technology
*Modeling and simulating viscoelastic flows, computational rheology, finite element methods for fluids, micro-macro simulations, interfacial phenomena*

Clark Givens
Professor
MS, The University of Michigan
*Applied linear algebra, signal processing, differential geometry, mathematical physics*

Mark S. Gockenbach
Professor and Department Chair
PhD, Rice University
*Inverse problems, computational optimization, mathematical software*

Renfang Jiang
Professor
PhD, Columbia University
*Group theory, low–dimensional topology, statistical genetics*

Melissa Keranen
Assistant Professor
PhD, Michigan Technological University
*Combinatorics*

Todd King
Associate Professor
PhD, University of Wyoming
*Mechanical Engineering*

Igor L. Kliakhandler
Associate Professor
PhD, Tel-Aviv University
*Applied mathematics: applied nonlinear partial differential equations, financial math, fluid mechanics, asymptotic analysis, computational math*

Robert W. Kolkka
Associate Professor; Adjunct Associate Professor of Chemistry and Chemical Engineering; Director, Fluids Research Oriented Group
PhD, Lehigh University
*Bifurcation and stability theory, viscoelasticity, non-Newtonian fluid mechanics, polymer rheology, constitutive equations*

Donald L. Kreher
Professor
PhD, University of Nebraska–Lincoln
*Combinatorics, computational combinatorics, combinatorial designs, coding theory, algorithms, cryptography*

Gilbert N. Lewis
Associate Professor
PhD, University of Wisconsin–Milwaukee
*Asymptotics, singular perturbations, numerical solutions of ordinary differential equations, boundary value problems, cosmology*

Phillip Merkey
Assistant Professor
Director of Computational Science and Engineering degree program
PhD, University of Illinois
*Computational Science and Engineering*

Shari Stockero
Assistant Professor
PhD, Western Michigan University
*Mathematical Education*

Tamara Olson
Associate Professor
PhD, New York University
*Applied mathematics, continuum mechanics, composites*

Iosif Pinelis
Professor
PhD, Institute of Mathematics–Novosibirsk, Russia
*Probability and statistics*

Ying Sha
Assistant Professor
PhD, Michigan Technological University
*Statistical Genetics*

Allan A. Struthers
Professor
PhD, Carnegie–Mellon University
*Applied mathematics, continuum mechanics, constitutive theory, phase transitions*

Franz X. Tanner
Professor
PhD, University of Illinois at Urbana-Champaign
*Applied mathematics, computational reacting multiphase flows, scientific computing, optimal control*

Vladimir D. Tonchev
Professor
DMSc, Bulgarian Academy of Sciences; PhD, University of Sofia, Bulgaria
*Algorithms, computing, coding theory, combinatorics, finite geometry*

Hillary VanSpronsen
Instructor (ABD)
MS, University of Montana, Missoula
*Mathematical Education*

Fabrizio Zanello
Assistant Professor
PhD, Queens University, Canada
*Commutative Algebra, Algebraic Combinatorics*

Shuanglin Zhang
Associate Professor
PhD, Beijing University, China
*Bioinformatics, statistical genetics, nonparametric function estimation, wavelets*