

## **Ph.D. Program Requirements and Administrative Rules for the Department of Mathematical Sciences**

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**1 Requirements for the Ph.D. Degree**

**1.1 Credit Requirements**

For the Ph.D. degree, a student must successfully complete a minimum of 90 semester hours of graduate work beyond the bachelor's degree (or a minimum of 60 semester hours beyond the master's degree), including at least 30 semester hours of dissertation research, as follows:

General Courses (credited for students with master's degrees)	30 credits
Research Preparation Phase	24-30 credits
Research-Related Courses or Independent Studies	9-18 credits
Ph.D. Project (see x5)	1-9 credits
Extra-Departmental Studies	6 credits
Dissertation Research	at least 30 credits

**1.2 Plan of Study**

No later than two weeks before the end of the first semester of study for full-time students (two weeks before the end of the second semester of study for part-time students), a student is required to submit a formal plan of study leading to the Ph.D. degree to the Graduate Committee for review. The plan of study may subsequently be modified with review by the Graduate Committee. International students may be required to provide their plans of study on a special form required by the U.S. government. Plan-of-study forms for both domestic and international students can be obtained from the departmental graduate secretary.

**1.3 General Comprehensive Examination - Candidacy for the Ph.D. Degree**

A student must pass the general comprehensive examination in order to become a Ph.D. candidate. See #6 for a description of the examination. A student who enters the Ph.D. program having passed an equivalent examination at another institution may petition the Graduate Committee to waive the general comprehensive examination.

## **1.4 Extra-Departmental Studies Requirement**

A student must complete at least six semester hours of courses, 500 level or higher, in WPI departments other than the Mathematical Sciences Department. Cross-listed courses can be counted toward meeting the extra departmental studies requirement. The student's advisor must approve the choice of cross-listed courses.

## **1.5 Mathematical Sciences Ph.D. Project**

A project may be completed for the Ph.D. degree. See #5 for a description of the project.

## **1.6 Preliminary Examination**

Successful completion of the preliminary examination is required before a student can register for dissertation credits. See #7 for a description of the examination and the examination committee. A student who enters the Ph.D. program having passed an equivalent examination at another institution may petition the Graduate Committee to waive the preliminary examination.

## **1.7 Dissertation Proposal**

At least six months prior to completion of the dissertation, a student must submit a written dissertation proposal to his or her dissertation committee and present a public seminar on the research plan described in the proposal. The proposal must be approved by the dissertation committee. See #8 for details.

## **1.8 Dissertation**

The completion and oral defense of a dissertation are required. See #8 for details.

## **1.9 Residency**

Full-time residency at Worcester Polytechnic Institute is required for at least one continuous academic year of graduate work. For more information, see the WPI Graduate Catalog or online at <http://www.wpi.edu/Pubs/Catalogs/Grad/Current/index.html>

## **1.10 Waivers**

In exceptional circumstances the Graduate Program Committee may waive or modify particular degree requirements and plans of study in response to a student petition.

## **2 Academic Advisor**

Upon entering the Ph.D. program, each student will be assigned an academic advisor by the Graduate Committee. It is the responsibility of the academic advisor to guide the student in initial course selection, to help the student fill out his or her plan of study, and to advise the student generally on matters pertaining to his or her academic program. A student may change academic advisors at any time with proper notice to the Graduate Committee.

### 3 Core Courses

The Department of Mathematical Sciences offers a number of core courses and independent studies at the 500 level. To provide structure, these are grouped into five core areas. The student entering with a bachelor's degree is required to select at least six courses from the list below.

#### 1. Mathematical Analysis

(a) Analysis I-II	MA 503 - MA 504
(b) Complex Analysis	MA 505
(c) Partial Differential Equations	MA 521
(d) Measure-Theoretic Probability	Independent Study

#### 2. Mathematical and Statistical Modeling

(a) Mathematical Modeling	MA 508
(b) Stochastic Modeling	MA 509
(c) Regression Analysis	MA 542
(d) Design and Analysis of Experiments	MA 546
(e) Linear Models	Independent Study

#### 3. Applied Mathematics and Scientific Computation

(a) Numerical Methods	MA 510
(b) Numerical Differential Equations	MA 512
(c) Numerical Linear Algebra	MA 514
(d) Optimal Control and Design with Composite Materials I-II	MA 525 - MA 526
(e) Partial Differential Equations	MA 521

#### 4. Algebra and Discrete Mathematics

(a) Linear Algebra	MA 502
(b) Discrete Mathematics I-II	MA 530 - MA 533
(c) Algebra	MA 535

#### 5. Mathematical Statistics

(a) Probability and Mathematical Statistics I-II	MA 540 - MA 541
(b) Measure-Theoretic Probability	Independent Study

### 4 Other Courses and Independent Studies

Other courses offered by the department are listed in the WPI Graduate Catalog. A list of independent study courses offered by faculty can be obtained from the departmental graduate secretary. Independent studies in addition to those listed can be arranged with faculty on an individual basis.

## 5 The Mathematical Sciences Ph.D. Project

A student may complete a Ph.D. project which can carry one to nine hours of Ph.D. credits. The project is expected to be equivalent to nine semester hours work. The purposes of the project are to broaden perspectives on the relevance and applications of mathematics and to improve skills in communicating mathematics and formulating and solving mathematical problems. Students are encouraged to work with industrial sponsors on problems involving applications of the mathematical sciences. The project must be started after the student has passed the general comprehensive examination. The policy governing the project is as follows:

- **Nature of the Project.** The project must involve a problem originating with a sponsor external to the department.
- **Faculty Project Advisor.** The project must be conducted under the supervision of a project advisor who is a tenured or tenure-track member of the Mathematical Sciences faculty.
- **Project Proposal.** Prior to the start of the project, a proposal outlining the nature, scope, and expected outcomes of the project must be approved by the project advisor, the external sponsor, and the Graduate Committee. The project proposal should identify the external sponsor, indicate where the project work is to take place, delineate a timeline for the project, and specify the number of credit hours to be obtained for the project.
- **Project Evaluation.** The project advisor is responsible for supervising and grading the project.
- **Project Report and Oral Presentation.** The project must culminate in a project report approved by the faculty project advisor and a public oral presentation at WPI.

## 6 The General Comprehensive Examination

### 6.1 Purpose and Structure

The purpose of the general comprehensive examination (GCE) is to determine whether a student possesses the fundamental knowledge and skills necessary for study and research at the Ph.D. level. It consists of two three-hour exams. For students planning a dissertation in mathematics, one exam is on real analysis, based on MA 503, and the other is on linear algebra, based on MA 502. For students planning a dissertation in statistics, the exams are on probability, based on MA 540, and mathematical statistics, based on MA 541.

Students are responsible for all topics listed in the WPI Graduate Catalog descriptions of the above courses as well as for related undergraduate prerequisite material.

## 6.2 Administration

The Graduate Program Committee is responsible for scheduling the GCE exams. It assigns the writing and grading of each exam to a group of faculty members. The Program Committee will then inform students about the results of these exams.

- **Schedule.** The GCE is offered three times a year, in January, May, and August. A student must register a request to take the GCE with the departmental graduate secretary at least one month before the proposed examination date.
- **Outcomes to pass the GCE.** Students must pass both exams by the end of January of their second year, if they entered the program in the fall, or by the end of May of their second year, if they entered in the spring. A student who passes the GCE becomes a Ph.D. candidate. A student who fails to pass both exams by this deadline will not be allowed to continue in the Ph.D. program.

## 7 The Preliminary Examination

### 7.1 Purpose and Structure

The purpose of the preliminary examination is to determine whether a student's understanding of advanced areas of mathematics is adequate to conduct independent research and successfully complete a dissertation. The examination is given in two parts, a written part followed by an oral part, and covers subject matter in three areas determined by the student's preliminary examination committee. The preliminary examination is intended to test a student's overall breadth in advanced mathematical topics as well as knowledge of his or her area of specialization, and the three areas should be chosen accordingly.

### 7.2 Administration

#### 7.2.1 Scheduling and Outcomes

A student must make the first attempt by the end of his or her third year (sixth year if part-time) in the Ph.D. program. The student must register a request to take the examination with the departmental graduate secretary at least two months in advance of the proposed date for the written part. The oral part must be conducted no more than one week after the written part. The preliminary examination committee is responsible for conducting the examination and informing the student of the outcome; see #7.2.2 for more details. A student who passes the examination is considered a dissertator and is allowed to register for dissertation credits. A student who fails will be allowed to take the examination a second time within one year of the first attempt. A student who fails a second time will not be allowed to continue in the Ph.D. program.

#### 7.2.2 Preliminary Examination Committee

A preliminary examination committee will be formed for each student taking the examination. This committee and its chair are appointed by the Graduate Committee upon notification by the

departmental graduate secretary, with due consideration given to suggestions by the student and his or her dissertation advisor. The committee chair must be a member of the Mathematical Sciences faculty other than the student's dissertation advisor. The other appointees must be members of the Mathematical Sciences faculty or faculty from other departments at WPI or other colleges or universities as may be desirable. The committee must have at least three members, including the chair.

The preliminary examination committee is responsible for making and grading the written part of the examination, conducting the oral part, and informing the student of the results. In case of failing, the committee decides which part or parts the student needs to re-take to pass the examination. The committee may exercise its discretion in handling any extenuating circumstances or problems.

## **8 The Dissertation**

The Ph.D. dissertation is a significant work of original research conducted under the supervision of a dissertation advisor. The dissertation advisor chairs the dissertation committee, which determines acceptability of the dissertation proposal and, upon completion, the dissertation.

### **8.1 Dissertation Advisor**

A student's dissertation advisor is normally a tenured or tenure-track member of the Mathematical Sciences faculty. For rules governing exceptions, see the WPI Graduate Catalog or online at <http://www.wpi.edu/Pubs/Catalogs/Grad/Current/index.html>.

### **8.2 Dissertation Committee**

A student's dissertation advisor chairs the dissertation committee. Under the direction of the advisor, the student selects the rest of the dissertation committee. The committee must have at least five members. The committee should be made up of members of the Mathematical Sciences faculty and at least one member external to the department who is a recognized expert in the area of the student's dissertation. The committee must be approved by the Graduate Committee.

This committee will participate in the dissertation proposal and the Oral examination. The committee must be selected at least two weeks prior to the public seminar on the dissertation proposal (see # 8.3).

### **8.3 Dissertation Proposal**

At least six months prior to completion of the dissertation, a student must present a formal seminar to the public describing his or her proposed dissertation research plan. A formal written dissertation proposal summarizing the proposed research plan must be submitted to the dissertation committee at least two weeks before this presentation. The proposal must be approved by the dissertation committee.

## 8.4 Final Examination - Oral Defense

The final examination is a public oral dissertation defense, the purpose of which is to present the dissertation to the dissertation committee and to the general community.

A student must register a request to schedule the oral defense with the departmental graduate secretary at least one month before the proposed date and must provide copies of his or her dissertation to each member of the dissertation committee at least one month prior to the oral defense. A student's dissertation committee, with the dissertation advisor acting as chairperson, determines by majority vote whether a dissertation is acceptable.

## 9 Examples of Ph.D. Tracks in Mathematical Sciences

Below are two examples of paths to the Ph.D. degree that might be taken by a full-time student supported by a teaching assistantship. Both examples assume the student takes 15 credits of research-related courses or independent studies within the department, six credits of extra-departmental courses, and nine credits of Ph.D. project work.

**Example 1.** The student arrives with a bachelor's degree: graduation in 5 years.

Year 1	General Courses (including Core Courses)	18 credits
	General Comprehensive Examination (may be taken between first and second years)	
Year 2	General Courses (including Core Courses)	12 credits
	Research-Related Courses or Independent Studies/Ph.D. Project/	
	Extra-Departmental Courses	6 credits
Year 3	Research-Related Courses or Independent Studies/ Ph.D. Project/	
	Extra-Departmental Courses	18 credits
Year 4	Research-Related Courses or Independent Studies/ Ph.D. Project/	
	Extra-Departmental Courses	6 credits
	Presentation of Dissertation Proposal	
	Dissertation Research	12 credits
Year 5	Dissertation Research	
	Dissertation Defense	18 credits

**Example 2.** The student arrives with a master's degree in applied mathematics or statistics: graduation in 3 years.

Year 1	General Comprehensive Examination (taken upon entering the Ph.D. program)	
	Research-Related Courses or Independent Studies/Ph.D. Project/	
	Extra-Departmental Courses	20 credits



Year 2	Research-Related Courses or Independent Studies/Ph.D. Project/ Extra-Departmental Courses	10 credits
	Preliminary Examination	
	Presentation of Dissertation Proposal	
	Dissertation Research	10 credits
Year 3	Dissertation Research	
	Dissertation Defense	20 credits