GRADUATE HANDBOOK
DEPARTMENT OF MATHEMATICAL SCIENCES
REVISED MAY 2022

Contents

1. Introduction

This handbook sets out rules and regulations that are specific to graduate study in the Department of Mathematical Sciences. University level policies and rules are set out in the University of Cincinnati Graduate School Graduate Handbook which is available online. Students are responsible for familiarizing themselves with the university requirements set out in the Graduate School's handbook.

Students should address questions concerning department policies to their advisor or to the Graduate Program Director. All requests for waivers of departmental requirements or other special consideration should be submitted in writing to the Graduate Affairs Committee.

2. PhD Program

2.1. General Description.

2.1.1. *Objectives.* The Doctor of Philosophy (PhD) in Mathematical Sciences represents achievement of a broad knowledge of the various branches of mathematics and statistics, of the ability to communicate mathematics in both written and oral form, and of a demonstrated creative ability in a particular branch of mathematics or statistics.

2.1.2. *Academic Admission Requirements.* Students applying for the program should have or be expecting to obtain a bachelor's degree either in mathematics or statistics with a strong mathematical foundation. Specifically, all students should have taken three semesters of calculus up to and including multivariate calculus; a semester course in linear algebra; a semester course in each of ordinary differential equations, calculus-based probability and statistics; elementary set theory and logic. In addition applicants should have taken or be taking advanced courses in mathematics or statistics at the level of the qualifying exams described below. Applicants intending to pursue a PhD in mathematics should have taken advanced undergraduate courses in linear algebra and analysis and additional advanced courses in pure and/or applied mathematics. Applicants intending to pursue a PhD in statistics should have taken courses in pure and applied statistics similar to STAT6021-2, and STAT6031-2.

A minimum score of 160 on the GRE quantitative section is expected for admission. Proficiency in English is expected of international students whose native language is not English. A minimum score of 80 on the internet-based TOEFL is required for admission. Also acceptable for admission are an overall band score of 6.5 on the International English Language Testing System (IELTS), a score of 56 on the PEARSON Test of English (PTE), or a score of 105 on the Duolingo English Test. To be eligible for a Graduate Assistantship, a student must achieve a TOEFL score of at least 93, IELTS overall band score of at least 7, PTE score of at least 64, or Duolingo score of at least 115. The English proficiency requirement is met for applicants with degrees earned in English from accredited universities and colleges in the US or other English speaking countries. The Graduate School maintains a list of countries eligible for a waiver of the English Language Testing requirement.

2.2. Requirements.

2.2.1. *Advisors.* Beginning graduate students are assigned a graduate advisor. Students should meet regularly with their advisors to discuss their programs of study. All courses taken by students should be approved in advance by their advisors. After passing the preliminary examinations, students select a dissertation advisor who will also serve as advisor from that period onward. The dissertation advisor must agree to serve in this capacity and must be a faculty member when the student makes the selection.

2.2.2. *Overview of University Requirements.* University rules and regulations concerning the PhD program are set out in the University of Cincinnati Graduate School's Graduate Handbook. We list below some of the most important requirements. It is the student's responsibility to read this document and to be aware of all university requirements concerning the PhD degree.

- Credit hour requirement: a minimum of 90 graduate credits beyond the bachelor's degree or a minimum of 60 credits beyond a master's degree, including at least 7 hours in dissertation research.
- Residency requirement: Prior to admission to doctoral candidacy, all PhD students shall complete a residency requirement by enrolling in 10 graduate credit hours per semester (12 if funded by a Graduate Assistantship) for two out of three consecutive semesters of study (including summer).
- Time restrictions: All requirements for the doctoral degree must be completed within nine consecutive years of the date of matriculation into the program.

2.2.3. *Overview of Departmental Requirements.*

- Qualifying examination
- Four preliminary examinations
- Breadth requirement
- Grade point average of at least 3.3
- Advanced examination
- Doctoral dissertation.

2.2.4. *Qualifying Examination.* All students must pass one of the two following qualifying exams.

- Mathematics Qualifying Exam covering advanced calculus and linear algebra (based on Advanced Calculus I MATH6001 and Abstract Linear Algebra MATH6003).
- Statistics Qualifying Exam based on the two two-semester sequences STAT6021-6022 (mathematical statistics) and STAT6031-6032 (applied statistics).

All incoming PhD students are required to take at least one qualifying exam before the beginning of their first semester. Students who do not pass this exam at the PhD level are placed in the appropriate 6000 - level courses. In order to remain in the PhD program, students must pass the Qualifying Exam at the PhD level by the beginning of the Fall Semester following their admission into the program.

2.2.5. *Preliminary Examinations.* All PhD students must pass four of the following preliminary examinations:

- Complex Analysis Preliminary Exam based on MATH7001;
- Real Analysis Preliminary Exam based on MATH7002;
- Algebra Preliminary Exam based on MATH7003;
- Topology Preliminary Exam based on MATH7004;
- Ordinary Differential Equations Preliminary Exam based on MATH7005;
- Partial Differential Equations Preliminary Exam based on MATH7006;
- Multivariate Analysis Preliminary Exam based on STAT7023;
- Theory of Linear Models Preliminary Exam based on STAT7024;
- Statistical Methods Preliminary Exam based on STAT7031;
- Probability Preliminary Exam based on STAT7032.

Each Preliminary Exam is offered twice a year. Examinations based on a course given during Fall Semester are offered after the end of Spring Semester and at the beginning of the following Fall Semester. Examinations based on a course given during the Spring Semester are offered at the beginning of the Fall Semester and at the beginning of the following Spring Semester.

Students are allowed to take each Preliminary Exam at most twice, but incoming PhD students who so desire may take one or more exams upon their arrival without these attempts counting against the two-attempt limit. After having completed their Qualifying Exam, students must pass all four of their Preliminary Exams within one and one-half full academic years.

Note: Prior to (and including) August 2018, the following five preliminary examinations were offered twice per year in May and August:

- Analysis Preliminary Exam based on Complex Analysis MATH7001 and Real Analysis MATH7002;
- Algebra and Topology Preliminary Exam based on Rings, Fields and Galois Theory MATH7003 and Topology MATH7004;
- Differential Equations Preliminary Exam based on Ordinary Differential Equations MATH7005 and Partial Differential Equations MATH7006;
- Linear Models Preliminary Exam based on Linear Models STAT7023-4;
- Probability and Statistics Preliminary Exam, based on Statistics Theory STAT7031 and Probability STAT7032.

with students required to pass two out of the five exams.

2.2.6. *Breadth Requirement.* The student, together with a graduate advisor, plans a program of study which will ensure the breadth of knowledge necessary for a professional mathematician or statistician. This program should include:

- at least five of the following 7000-level courses
  - MATH7001 Complex Analysis
  - MATH7002 Real Analysis
  - MATH7003 Rings, Fields and Galois Theory
  - MATH7004 Topology
  - MATH7005 Ordinary Differential Equations
  - MATH7006 Partial Differential Equations
  - MATH7011 Advanced Mathematical Modeling

  - MATH7015 Numerical Linear Algebra
  - STAT7020 Topics in Applied Statistics*
  - STAT7023-4 Linear Models and Multivariate Analysis I and II
  - STAT7031 Statistics Theory
  - STAT7032 Probability
- at least four of the following 8000-level and 9000-level courses
  - MATH8001 Geometric Function Theory
  - MATH8002 Geometric Analysis
  - MATH8003 Functional Analysis
  - MATH8004 Operator Theory
  - MATH8005 Introduction to Algebraic Geometry
  - MATH8006 Algebra and Cryptography
  - MATH8007 Advanced Stochastic Processes
  - MATH8008 Stochastic Differential Equations
  - MATH8009 Advanced Partial Differential Equations
  - MATH8010 Advanced Numerical Analysis
  - MATH8011 Scientific Computation
  - MATH8012 Applied Mathematics Methods
  - MATH9001 Advanced Financial Mathematics
  - STAT8021 Advanced Theory of Statistics
  - STAT8022 Advanced Bayesian Analysis
  - STAT8023 Advanced Statistics Computing
  - STAT8024 Advanced Statistical Modeling
  - STAT8025 Spatial Statistics

*Note: STAT7020 is a topics course whose syllabus may vary from year to year. It may be taken and counted up to two times towards the breadth requirement, subject to the approval of the Graduate Program Director.

On the approval of the Graduate Affairs Committee, graduate courses from other departments may be counted towards the breadth requirement if they are relevant to the student's program of study. A GPA of 3.3 or better is required in the breadth requirement courses.

2.2.7. *Advanced Examinations.* An advanced examination in the area of specialization of the student is required. To apply for an advanced examination, a student must have successfully completed the required number of preliminary examinations, and must have chosen an area for the dissertation. An advanced exam may either be a written exam, a presentation or a series of presentations. A pass on the advanced exam should indicate that a student has gained the appropriate mathematical maturity and advanced knowledge of his/her field of research to write a successful PhD thesis. The exam will be administered by a committee assembled along the lines of a Dissertation Committee (see Section 2.2.9 below). Generally this committee will form the student's dissertation committee but this is not a requirement. Advanced exams must be scheduled at least a month in advance of the proposed date by the student's advisor. The advisor will provide the GPD with the names of the proposed committee members and the proposed format and date of the examination. The exam will then be officially scheduled by the Graduate Program Director. If a student does not pass an advanced exam, then at least one month must pass before another attempt is scheduled. The advanced examination must be passed within four years of entrance into the PhD program.

2.2.8. *Admission to Candidacy.* After completing the preliminary exams, the breadth requirement and the advanced exam the student will be admitted to candidacy. At this point the student works full-time on his or her dissertation research. This part of the program usually requires 1-3 years of study. Occasionally, students will leave to take full-time employment while continuing to work on their dissertations. In this situation, the student must register for at least one graduate credit hour each academic year in order to maintain graduate student and candidacy status.

2.2.9. *Dissertation.* A student is required to present a dissertation which demonstrates high scholarly achievement through original and independent research.

After a Ph.D. student has passed the required number of preliminary examinations, the student should select a dissertation advisor who will also serve as advisor from that period onward. The dissertation advisor

must agree to serve in this capacity and must be a faculty member at the time the student makes the selection. The research topic is to be selected by the student in consultation with the dissertation advisor.

At the time a student is admitted into Candidacy, the Dissertation Committee is formed by the Graduate School on the recommendation of the Graduate Program Director in consultation with the dissertation advisor and the student. The committee consists of 3-5 persons admissible under the rules of the Graduate School set out in the UC Graduate Handbook. At least three of the committee members must be tenure-track members of the Department of Mathematical Sciences, with at least two of these three tenured. The chair of the committee must be a tenure-track member of our department. However, the chair of the committee does not need to be the sole, or even the primary dissertation advisor. Any subsequent changes in the dissertation committee will also be made by the Graduate School upon recommendation of the Graduate Program Director in consultation with the committee chair and student. Students have the right to request a change in the committee but must do so in consultation with the Graduate Program Director

When the student and the advisor deem the dissertation to be complete, a copy of it is submitted to each committee member for critical evaluation. The Committee can make recommendations to the student concerning extensions or other avenues of research related to the dissertation problem at this time or can recommend that the defense be scheduled. Students should not schedule a dissertation defense before receiving the approval of the committee.

At least two weeks before the open defense, electronic copies of the dissertation in the proposed final form should be distributed to all Dissertation Committee members. The defense of the dissertation is open to all members of the academic community and to the public. The candidate answers questions posed by members of the committee following an oral presentation of his or her dissertation. After the committee members have completed their questioning, others present may pose questions or comments. At the conclusion of the defense, the committee will withdraw, make a decision with regard to the acceptability of the dissertation and its defense, and report its decision to the candidate. At least three-quarters of the voting members of the dissertation committee must approve the dissertation.

2.3. **Program Standards.**

2.3.1. *Normal Progress.* Students entering the program with a master's degree are expected to complete the program within 5 years; those entering with only a bachelor's degree are expected to complete the program in 6 years. More specifically they are expected to:

- Pass a qualifying exam at the PhD level by the beginning of the second academic year. Students who fail to do so will be dismissed from the PhD program. If they have passed the qualifying exam at the MS level, they will be permitted to switch to the MS program, but will lose financial support.
- Pass four preliminary exams within one and one-half academic years of passing the qualifying exam. Students who fail to do so will be dismissed from the PhD program.
- Complete the breadth requirement and the advanced exam within two years of passing preliminary exams.

2.3.2. *Annual Review.* Each year at the end of the Fall Semester, PhD students will receive a written annual review of their progress from the Graduate Program Director in consultation with the student's advisor. For students who are also Graduate Assistants, reviews will also contain a report on the performance of their GA duties.

2.3.3. *Minimum Academic Performance and Probation.* A student will be placed on probation if he or she fails to maintain a minimum academic performance. Minimum academic performance includes

- maintaining a GPA of at least 3.3 in graduate courses in mathematical sciences;
- taking courses appropriate to the candidate's program of study;
- taking an appropriate course load. In particular, after PhD students pass their Qualifying Exams and until they are advanced to candidacy, they are expected to take at least one regular course from the Department of Mathematical Sciences at the 7000 level or higher each semester.
- choosing a dissertation advisor and passing an advanced examination within the required time limit;
- advancing to candidacy within the appropriate time limit;
- making adequate progress on the dissertation.

A student placed on probation will receive a letter from the Graduate Program Director outlining the reasons for the probation and the steps that the student needs to take to rectify the situation. Failure to achieve the required performance standards in the prescribed time period may result in non-renewal of financial support or dismissal from the program.

3. Master of Science in Mathematical Sciences

3.1. **General Description.** The Master of Science (MS) in Mathematical Sciences degree program is a three-semester course of study that develops the student's understanding of mathematics beyond that obtained in a standard undergraduate program. A graduate of the MS program is prepared to enter the workforce as a professional mathematical scientist. An appropriate choice of courses will also prepare students to pursue a PhD

3.2. **Admission Requirements.** Students applying for the program should have or be expecting to obtain a bachelor's degree either in mathematics or in a related area with a strong mathematical foundation. Specifically, students should have taken:

- Three semesters of calculus up to and including multivariate calculus
- A semester course in ordinary differential equations
- A semester course in linear algebra

Students should have a grade point average of at least 3.0 (a "B" average) in these courses.

A minimum score of 155 on the GRE quantitative section is expected for admission. However the GRE requirement may be waived if taking the GRE creates a financial hardship for the applicant. Proficiency in English is expected of international students whose native language is not English. A minimum score of 80 on the internet-based TOEFL is required for admission. Also acceptable for admission are an overall band score of 6.5 on the International English Language Testing System (IELTS), a score of 56 on the PEARSON Test of English (PTE), or a score of 105 on the Duolingo English Test. The English proficiency requirement is met for applicants with degrees earned in English from accredited universities and colleges in the US or other English speaking countries. The Graduate School maintains a list of countries eligible for a waiver of the English Language Testing requirement.

3.3. **Program Requirements.**

3.3.1. *Total Credit Hours.* A minimum of 30 graduate credits are required with a GPA of 3.0 or higher. All credits must be approved by an advisor and at least 24 of these should be graduate mathematics or statistics courses. Of the courses taken to fulfill the 30 credits, at least three should come from the following list:

- MATH7001 Complex Analysis
- MATH7002 Real Analysis
- MATH7003 Rings, Fields and Galois Theory
- MATH7004 Topology
- MATH7005 Ordinary Differential Equations
- MATH7006 Partial Differential Equations
- MATH7011 Advanced Mathematical Modeling
- MATH7015 Numerical Linear Algebra
- STAT7032 Probability
- MATH8001 Geometric Function Theory
- MATH8002 Geometric Analysis
- MATH8003 Functional Analysis
- MATH8004 Operator Theory
- MATH8005 Introduction to Algebraic Geometry
- MATH8006 Algebra and Cryptography
- MATH8007 Advanced Stochastic Processes
- MATH8008 Stochastic Differential Equations
- MATH8009 Advanced Partial Differential Equations
- MATH8010 Advanced Numerical Analysis
- MATH8011 Scientific Computation
- MATH8012 Applied Mathematics Methods
- MATH9001 Advanced Financial Mathematics

3.3.2. *Tracks.* Students must choose between three tracks: Pure Mathematics, Applied Mathematics and Financial Mathematics. Each track has a core of classes that the students must take. The remaining credits are chosen from a list of electives. In exceptional circumstances a student may substitute a course not on the

list of electives. All such substitutions must be approved in advance and in writing by the student's advisor and the Graduate Program Director.

3.3.3. *Pure Mathematics.*

- Required Core*:
  - MATH6001 Advanced Calculus I
  - MATH6002 Advanced Calculus II
  - MATH6003 Abstract Linear Algebra
- Recommended Electives (three courses are required)
  - MATH6004 Group Theory
  - MATH6005 Introduction to Complex Analysis
  - MATH7001 Complex Analysis
  - MATH7002 Real Analysis
  - MATH7003 Rings, Fields and Galois Theory
  - MATH7004 Topology
  - MATH7005 Ordinary Differential Equations
  - MATH7006 Partial Differential Equations
  - STAT7032 Probability
- Other Electives
  - MATH6006 Numerical Analysis
  - MATH6007 PDE and Fourier Analysis
  - MATH6008 Applied Probability and Stochastic Processes
  - MATH8001 Geometric Function Theory
  - MATH8002 Geometric Analysis
  - MATH8003 Functional Analysis
  - MATH8004 Operator Theory
  - MATH8005 Introduction to Algebraic Geometry
  - MATH8006 Algebra and Cryptography
  - MATH8007 Advanced Stochastic Processes
  - MATH8008 Stochastic Differential Equations
  - MATH8009 Advanced Partial Differential Equations
  - STAT6021 Mathematical Statistics I
  - STAT6022 Mathematical Statistics II

  *Students have the option of taking the Mathematics PhD Qualifying Exam before entering the program. Students passing this exam are not required to take MATH 6001 or MATH 6003, but still must complete 30 graduate credits.

3.3.4. *Applied Mathematics.*

- Required Core:
  - MATH6006 Numerical Analysis
  - MATH6007 PDE & Fourier Analysis
  - MATH6012 Applied Linear Algebra (or MATH6003)
  - MATH6015 Mathematical Programming
  - MATH7011 Advanced Mathematical Modeling
- Recommended Electives:
  - MATH6019 Nonlinear Optimization
  - MATH7015 Numerical Linear Algebra
  - MATH8010 Advanced Numerical Analysis
  - MATH8011 Scientific Computation
  - MATH8012 Applied Mathematics Methods
- Other Electives:
  - MATH6001 Advanced Calculus I
  - MATH6002 Advanced Calculus II
  - MATH6005 Introduction to Complex Analysis
  - MATH6008 Applied Probability and Stochastic Processes

  - MATH7005 Ordinary Differential Equations
  - MATH7006 Partial Differential Equations
  - Up to six graduate credits from other departments, approved in advance by the student's advisor

3.3.5. *Financial Mathematics.*

- Required Core:
  - MATH6010 Probabilistic Aspects of Financial Modeling
  - MATH6011 Computational Financial Mathematics
  - STAT6031 Applied Regression Analysis (Applied Statistics I prior to Fall 2021)
- Recommended Electives:
  - MATH6006 Numerical Analysis
  - MATH6007 PDE & Fourier Analysis
  - MATH6008 Applied Probability and Stochastic Processes
  - MATH6019 Nonlinear Optimization
  - MATH7006 Partial Differential Equations
  - MATH8008 Stochastic Differential Equations
  - MATH9001 Advanced Financial Mathematics
  - STAT6041 Time Series
- Other Electives:
  - MATH6012 Applied Linear Algebra
  - MATH6015 Mathematical Programming
  - MATH7011 Advanced Mathematical Modeling
  - MATH7015 Numerical Linear Algebra
  - STAT7032 Probability
  - Up to six graduate credits in finance and economics, approved in advance by the student's advisor.

3.3.6. *Master's Thesis.* A student may write a Master's thesis on a topic chosen in consultation with the student's advisor in lieu of 4 credits of formal course work. An expository thesis is acceptable for the MS. A formal thesis defense is optional and may be used to replace the oral examination (see below).

3.3.7. *Oral Examination.* Students must pass an oral examination which tests their ability to communicate orally the fundamental concepts of the core classes in their track. The oral exam lasts one hour and may be taken at any time after the student has taken and passed the core classes. It begins with a 20 minute presentation by the students on a subject of their choice from their core classes and is followed by a question and answer session. The examination committee consists of three faculty members usually chosen from those who taught courses taken by the examinee. Students who write and defend a master's thesis are exempt from the oral examination.

3.4. **Minimum Academic Performance.** Students must maintain a minimum academic performance at all times while in the MS program. Minimum academic performance includes

- maintaining a GPA of at least 3.0 in graduate courses in mathematics;
- taking courses appropriate to the student's program of study;
- taking an appropriate course load.

Failure to maintain a satisfactory performance may result in probation, non-renewal of financial aid or dismissal from the program.

3.5. **Examples of Programs of Study.** Each student in the program is assigned a graduate advisor. In consultation with this advisor, the student selects a program of courses designed to provide basic training in mathematics at the graduate level and in-depth study in areas of special interest.

Listed below are some sample programs for students with different backgrounds.

3.5.1. *Basic Mathematical Background.* The following *sample* programs are appropriate for a student with the minimum entrance requirements.

Pure Mathematics Sample Program

Year 1		Year 2
Fall	Spring	Fall
MATH6001 Adv. Calc. I	MATH6002 Adv. Calc. II	MATH6006 Num. Analysis
MATH6003 Abstract Lin. Alg.	MATH6004 Group Theory	MATH7004 Topology
MATH6005 Intro. Complex	MATH7001 Complex Analysis	MATH7005 ODE
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

Applied Mathematics Sample Program

Year 1		Year 2
Fall	Spring	Fall
MATH6005 Intro. Complex	MATH6007 PDE and FA	MATH7005 ODE
MATH6006 Num. Analysis	MATH6015 Math. Programming	MATH8010 Adv. Num. Analysis
MATH6012 Appl. Lin. Alg.	MATH7011 Adv. Math. Model.	MATH8012 Appl. Math. Meth.
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

Financial Mathematics Sample Program

Year 1		Year 2
Fall	Spring	Fall
MATH6006 Num. Analysis	MATH6010 Prob. Fin. Mod.	STAT6041 Time Series
MATH6008 Appl. Prob. Stoch.	MATH6011 Comp. Fin. Math.	MATH8010 Adv. Num. Analysis
STAT6031 Appl. Regression	STAT7032 Probability	MATH9001 Adv. Fin. Math.
**Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

3.5.2. *Strong Mathematical Background.* Students entering the Pure Mathematics track with significant mathematical experience may take the PhD qualifying exam in August before classes start. If they successfully pass the qualifying exam they will not have to take the corresponding courses and can create a more challenging curriculum that includes more 7000 and 8000 level classes. Some examples of possible courses of study are given below.

Pure Mathematics Sample Program

Year 1		Year 2
Fall	Spring	Fall
MATH6005 Intro. Complex	MATH6004 Group Theory	MATH7004 Topology
MATH7002 Real Analysis	MATH7001 Complex Analysis	MATH8002 Geom. Analysis
MATH7005 ODE	MATH7006 PDE	MATH8003 Funct. Analysis
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

Similarly, a student entering the Applied Mathematics track with significant mathematical experience can create a more challenging applied mathematics curriculum such as:

Applied Mathematics Sample Program

Year 1		Year 2
Fall	Spring	Fall
MATH6005 Intro. Complex	MATH6015 Math. Programming	MATH6008 Appl. Prob. Stoch.
MATH7005 ODE	MATH7006 PDE	MATH8011 Sci. Computation
MATH8010 Adv. Num. Analysis	MATH7011 Adv. Math. Model.	MATH8012 Appl. Math. Meth.
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

3.5.3. *Preparation for the PhD Program.* Entrance into the PhD program requires a strong background in theoretical mathematics. All PhD students must pass the qualifying exam in Advanced Calculus and Linear Algebra at the PhD level by the end of their first year. A student in applied or financial mathematics wishing to continue into the PhD program should be sure to gain competency in these subjects.

4. Master of Science in Statistics

4.1. **General Description.** The Master of Science (MS) in Statistics degree program is intended to prepare students for careers as statisticians or for entry into a PhD program in Statistics. A student entering with the minimum requirements should expect to take two years to complete the program. Students entering the program with a stronger background in statistics may be able to complete the program in three or even two semesters.

Students applying for the program should have or be expecting to obtain a bachelor's degree in either mathematics or statistics, or in a related area with a strong mathematical foundation. Specifically, applicants should have taken:

- Three semesters of calculus up to and including multivariate calculus
- A semester course in linear algebra
- A semester course in calculus-based probability and statistics

Applicants should have a grade point average of at least 3.0 (a "B" average) in these courses.

A minimum score of 155 on the GRE quantitative section is expected for admission. However the GRE requirement may be waived if taking the GRE creates a financial hardship for the applicant. Proficiency in English is expected of international students whose native language is not English. A minimum score of 80 on the internet-based TOEFL is required for admission. Also acceptable for admission are an overall band score of 6.5 on the International English Language Testing System (IELTS), a score of 56 on the PEARSON Test of English (PTE), or a score of 105 on the Duolingo English Test. The English proficiency requirement is met for applicants with degrees earned in English from accredited universities and colleges in the US or other English speaking countries. The Graduate School maintains a list of countries eligible for a waiver of the English Language Testing requirement.

4.2. **Requirements.**

4.2.1. *Course requirements.* A minimum of 30 graduate credits are required with a GPA of 3.0 or higher. The following courses are required:

- STAT6021 Mathematical Statistics I
- STAT6022 Mathematical Statistics II
- STAT6031 Applied Regression Analysis (Applied Statistics I prior to Fall 2021)
- STAT6032 Design and Analysis of Experiments (Applied Statistics II prior to Fall 2021)
- STAT7023 Linear Models and Multivariate Analysis I
- STAT7024 Linear Models and Multivariate Analysis II or STAT7020 Topics in Applied Stats

Moreover students must have a GPA of 3.0 or higher on this set of six courses. Two further courses must be chosen from the following list:

- STAT6041 Time Series
- STAT6042 Survival Analysis and Logistic Regression
- STAT6043 Applied Bayesian Analysis
- STAT6044 Nonparametric Statistics
- STAT6045 Statistical Computing with SAS and S-plus
- STAT6051 Statistical Consulting
- STAT6071 Statistics and Machine Learning
- STAT7020 Topics in Applied Statistics
- STAT7024 Linear Models and Multivariate Analysis II

At least four additional graduate credits may be chosen from graduate statistics (STAT) or mathematics (MATH) courses (excluding STAT Readings), or from approved graduate courses from the Division of Biostatistics and Bioinformatics of the Department of Environmental Health, the Center for for Business Analytics of the College of Business, or the Department of Electrical Engineering and Computer Science of the College of Engineering. The Graduate Colloquium, Research, and the Proseminar in the Teaching of College Mathematics credits cannot be applied toward the degree. At most, 4 credits of Readings or Individual Work can be applied toward the degree and then only upon written recommendation of both the supervisor of the readings and the GPD. Students working on an approved internship may apply up to six

hours credit (STAT8026 Practicum in Applied Statistics) towards their degree conditional on the approval of their advisor.

Students entering the program having already taken courses such as 6031-6032 (applied statistics) may have such requirements waived but are still required to take 30 graduate credits of statistics courses. In this situation, students may be recommended to take courses offered by the departments listed above. Up to six such credits are allowed on approval of the student's advisor.

4.2.2. *Qualifying Examination.* A Qualifying Examination in Statistics takes place every year in May and August. It is based on the two two-semester sequences STAT6021–6022 (mathematical statistics) and STAT6031–6032 (applied statistics). There are three possible outcomes for the exam: pass at the PhD level; pass at the MS level; and fail. All full-time students must pass the Qualifying Examination in Statistics at least at the MS level by the end of their first year. A pass at the PhD level exempts the student from the oral exam.

4.2.3. *Oral Examination.* Students must pass a comprehensive oral examination based on the material covered in the courses taken in fulfillment of the degree requirements. Knowledge of linear algebra is expected of all students who earn an MS degree and questions on this subject may be asked on the oral examination. The examination committee consists of three faculty members usually chosen from those who taught courses taken by the examinee. Students who pass the qualifying exam at the PhD level or defend a master's thesis are exempt from the oral examination requirement.

4.2.4. *Master's Thesis.* A student may write a Master's thesis on a topic chosen in consultation with the student's advisor in lieu of 4 credits of formal course work. An expository thesis is acceptable for the MS. The thesis must be of sufficient quality to earn the grade of B. A formal thesis defense is optional and can be held in lieu of an oral examination.

4.3. **Minimum Academic Performance.** Students must maintain a minimum academic performance at all times while in the MS program. Minimum academic performance includes

- maintaining a GPA of at least 3.0 in graduate courses in statistics;
- taking courses appropriate to the student's program of study;
- taking an appropriate course load.

Failure to maintain a satisfactory performance may result in probation, non-renewal of financial aid or dismissal from the program.

4.4. **Examples of Programs of Study.** Each student in the program is assigned a graduate advisor. In consultation with this advisor, the student selects a program of courses designed to provide basic training in mathematics at the graduate level and in-depth study in areas of special interest.

Listed below are some sample programs for students with different backgrounds.

4.4.1. *Basic Statistical Background.* The following sample program is appropriate for a student with the minimum entrance requirements. The program can be completed in 3 or 4 semesters.

Year 1		Year 2
Fall	Spring	Fall
STAT6021 Math. Stat. I	STAT 6022 Math. Stat. II	STAT6041 Time Series
STAT6031 Appl. Regression	STAT6032 Design of Exp.	STAT7020 Topics Appl. Stat.
MATH6012 Appl. Lin. Alg.	STAT6045 Stat. Comp.	STAT7023 Linear Models I
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

4.4.2. *Strong Statistical Background.* The following sample program is appropriate for a student who enters the program with a strong background in statistics. In particular the student must have successfully completed the equivalent of the introductory 6000-level sequences in mathematical and applied statistics. A student in this situation should be able to complete the program in three semesters of full-time study.

Year 1		Year 2
Fall	Spring	Fall
STAT6041 Time Series	STAT6043 Appl. Bayesian	STAT6042 Survival Analysis
STAT6044 Non-Parametric	STAT6045 Stat. Comp.	STAT 7020 Topics Appl. Stat.
STAT7023 Linear Models I	STAT7024 Linear Models II	STAT7031 Stat. Theory
*Elective	*Elective	*Elective

*One additional elective is required that can be taken in any term.

5. Graduate Certificate in Statistical Science

5.1. **General Description.** The Graduate Certificate in Statistical Science is a two-semester course of part-time study that equips students with applied statistical techniques beyond those covered in a standard undergraduate program. A graduate of the certificate program is prepared to perform statistical data analysis in a variety of professional contexts.

5.2. **Admission Requirements.** Students applying for the program should have or be expecting to obtain a bachelor's degree in a discipline that employs data analysis. Furthermore, students should have taken STAT 2037 and STAT 3038 or equivalent courses (i.e., two semesters of calculus-based probability and statistics) with a grade of B or higher in each course.

5.3. **Requirements.** A minimum of 12 graduate credits are required with a GPA of 3.0 or higher with no individual course grade lower than B–. The following courses are required:

- STAT6031 Applied Regression Analysis
- STAT6032 Design and Analysis of Experiments*
- STAT6045 Statistical Computing with SAS and S-Plus

One further course must be chosen from the following list:

- STAT6041 Time Series
- STAT6042 Survival Analysis and Logistic Regression
- STAT6043 Applied Bayesian Analysis
- STAT6044 Nonparametric Statistics
- STAT6051 Statistical Consulting
- STAT6071 Statistics and Machine Learning
- Any other graduate (6000-level or higher) STAT course, with advisor approval.
- Any other graduate (6000-level or higher) course with significant statistical content, with approval of the Graduate Program Director.

Students entering the program with appropriate background may have specific course requirements waived but are still required to complete 12 graduate credits of statistics courses.

*If appropriate for the student's educational goals, STAT 6032 may be replaced by another STAT course at the 6000-level or higher with permission of the Graduate Program Director.

5.4. **Financial Support.** It is university policy that students enrolled only in a graduate certificate program are not eligible for tuition or stipend support with University funds.

6. Financial Support

6.1. **University Graduate Awards.**

6.1.1. *Graduate Assistantships.* Graduate Assistantships (UGA) are financial stipends awarded for services rendered to the department. Students who are not eligible to assume direct instructional duties (international students who have not passed the OEPT requirement) receive the base stipend. Pre-candidacy students who are eligible to assume direct instructional duties receive the regular stipend, which is higher than the base stipend. PhD students who have advanced to candidacy receive an increased stipend, starting with the semester following advancement to candidacy. Graduate Assistants are expected to perform duties for the Department as detailed in Section 6.2.4 below. All students with GAs are required to pass the Proseminar in the Teaching of College Mathematics (MATH 9040) as soon as possible after being awarded the GA.

6.1.2. *Fellowships.* A variety of fellowships are available to graduate students. More details on fellowship opportunities are available on the department's website. Advanced PhD students are expected to apply for the Taft Graduate Fellowships. Note that fellowships that are accompanied by GASs or GIAs (see below) are subject to Ohio's 174 credit hour rule described in Section 6.2.2.

6.1.3. *Graduate Assistant Scholarships.* The Graduate Assistant Scholarship (GAS) is a university-funded scholarship that covers all of a full-time student's tuition and fees, except those fees specifically excluded by the University. All Graduate Assistants receive GASs, as do Research Assistants funded through University grants and contracts.

Students receiving a GAS must be registered for at least 12 graduate credit hours in each semester for which they are receiving support. Audited courses and withdrawn courses (after the withdrawal date) do not count toward the registration requirement. Students registered for more than 18 credits in a semester will be billed tuition and general fees on a per-credit-hour rate for each credit over the 18. If a student withdraws from a class and falls below the required minimum number of registered graduate credit hours, the GAS is cancelled immediately and the student is responsible for the tuition balance, based on the date of withdrawal.

6.1.4. *Graduate Incentive Awards.* The Graduate Incentive Award (GIA) is a university-funded scholarship that covers part of a full-time student's tuition and fees. Students receiving a GIA must be registered for at least the number of graduate credit hours covered by the GIA in each semester for which they are receiving support. Audited courses and withdrawn courses (after the withdrawal date) do not count toward the registration requirement. Students registered for more than 18 credits in a semester will be billed tuition and general fees on a per-credit-hour rate for each credit over the 18. If a student withdraws from a class and falls below the required minimum number of registered graduate credit hours, the GIA is cancelled immediately and the student is responsible for the tuition balance, based on the date of withdrawal.

6.1.5. *Internships and External Support.* Students supported by employment through a University grant or contract (called an "internship" below) are eligible for a 90% GIA provided the support satisfies the following conditions:

(1) The internship should have a character that is similar to a research assistantship funded by an external grant.
(2) The work performed under the internship should be aligned with the academic interests and career trajectory of the student.
(3) The internship should involve 16-20 hours work per week for 15 weeks each semester during which a GIA is awarded, and should be remunerated at a rate at least equivalent to a graduate assistantship.

All such internships must be approved by the GPD in order for a GIA to be awarded. Interns should register for at least 10 graduate credit hours, unless the GIA is specifically awarded for a lesser amount. As with other Graduate Incentive Awards, audited courses and withdrawn courses (after the withdrawal date) do not count toward the registration requirement.

6.1.6. *Summer Support.* There are a number of opportunities for summer financial support. Each year the department offers some summer teaching opportunities for graduate students. More details on fellowship opportunities are available on the department's website. Continuing PhD students with strong academic records may apply for the competitive summer research fellowships awarded by the University Research Council (URC) and for Maita Levine Summer Research Fellowships awarded by the department.

6.1.7. *Miscellaneous Financial Support.* The GPD may introduce other student award programs besides the ones listed above if funds are available to support them. Decisions on these awards will be made by the GPD in consultation with the Graduate Students Evaluation Committee.

6.2. **Conditions of Financial Aid.**

6.2.1. *Award Criteria.* Decisions on the award of Graduate Assistantships are made by the Graduate Students Evaluation Committee (GSEC). Awards to beginning students are made on the basis of academic merit. All awards are renewed annually provided the student has made satisfactory progress in his or her program as detailed in Section 2.3 and has performed his or her duties in a satisfactory fashion.

In general, decisions for renewal of financial aid are made by April. Decisions are delayed if a student needs to satisfy certain conditions in order to stay in the program (e.g., pass preliminary examinations, improve the GPA, improve performance of his/her duties, or some probationary condition). A decision of the GSEC not to renew the current level of financial aid to a student can be appealed to the Graduate Affairs Committee.

6.2.2. *Time Restrictions.* Financial support for PhD students is limited by the state of Ohio's 140/174 credit hour rule outlined in the University Graduate Handbook. Here "financial support" means support of any kind from the University of Cincinnati and includes Graduate Assistantships, Graduate Assistant Scholarships and Graduate Incentive Awards.

6.2.3. *University Requirements.* The University requirements for recipients of graduate awards are outlined in the University Graduate Handbook available online at the Graduate School's website grad.uc.edu. It is important that all students familiarize themselves with these rules.

6.2.4. *Graduate Assistant Duties.* Nearly all GA duties are instructional. Typically, a GA holds 4 office hours in the Math and Science Support Center, conducts problem sessions and grades for two or three courses while classes are in session, for an average of not more than 16 hours a week. International GAs who have not yet passed UC's Oral English Proficiency Test are generally given grading duties. More experienced GAs may be assigned full instructional responsibility for a class.

GAs are expected to perform their duties to the best of their capabilities and according to acceptable procedures, with punctuality, reliability, and a spirit of helpfulness to fellow teachers and students. GAs should act responsibly and with integrity at all times. If for a compelling reason they cannot perform some tasks (for example due to illness or conflict with the student's own academic obligations), they must minimize the disruption to others by finding substitutes, informing the department in a timely manner, and taking whatever other initiatives are appropriate for the situation.

6.2.5. *Oral English Proficiency Testing (OEPT).* All GAs whose native language is not English must pass the University's Oral English Proficiency Test with a score of 3.0 or above before they are allowed to have any direct instructional contact with students such as teaching, assisting in a class, holding office hours, etc. International GAs who have not satisfied this requirement by the end of March of their second year will not be eligible for renewal of their assistantship and GAS.

Students who have scored 26 or higher on the speaking section of the TOEFL IBT, 7.5 or higher on the speaking portion of the IELTS, or 50 or higher on the Test of Spoken English (TSE) do not need to take the OEPT. The English proficiency requirement is also met for students with degrees earned in English from accredited universities in the US or other English speaking countries. The Graduate School maintains a list of countries eligible for a waiver of the English Language Testing requirement.