

# MATHEMATICS, APPLIED AND INDUSTRIAL (PHD)

## Doctor of Philosophy in Applied and Industrial Mathematics (MATHPHD)

Unit: College of Arts and Sciences (<http://louisville.edu/artsandsciences/intro>) (GA)

Department/Program Webpage (<https://louisville.edu/math/graduate>)

## Program Information

The University of Louisville Department of Mathematics is a research-oriented department that prides itself on delivering first-rate graduate instruction. There are a broad range of courses and ample opportunities to interact with faculty. The Department also maintains an active colloquium series with talks given by visiting mathematicians, statisticians and scientists.

The PhD program in Applied and Industrial Mathematics offers a blend of advanced mathematical and statistical knowledge with the experience to apply that knowledge. Students completing the program have a unique perspective from which they can see the whole of mathematics integrated with applied and industrial needs. A broad and rigorous mathematical core combined with customized application electives and an industrial internship prepares students with life-long career skills in teaching, research, and industry.

## Prerequisites

Undergraduate coursework equivalent to a major in mathematics from an accredited university. This should include at least a one-year course in either analysis or abstract algebra, equivalent to MATH 501-MATH 502 and MATH 521-MATH 522 at the University of Louisville.

Candidates who have not taken both must complete the second in their program.

## Dual Degree Program in Applied and Industrial Mathematics (PhD) and Biostatistics (MS)

Dual degrees in Biostatistics and Applied and Industrial Mathematics are offered by the College of Arts and Sciences and the School of Public Health and Information Sciences. Upon completion of the program, students will receive a PhD in Applied and Industrial Mathematics and a Master of Science in Biostatistics.

## Admission Requirements

Interested applicants should have completed undergraduate coursework equivalent to a major in mathematics from an accredited university. This should include at least a one-year course in either analysis or abstract algebra, equivalent to MATH 501-MATH 502 and MATH 521-MATH 522 at the University of Louisville.

Candidates who have not taken both sequences must complete the second in their program.

Prospective students can apply online at [louisville.edu/graduate/futurestudents/apply-materials/application](http://louisville.edu/graduate/futurestudents/apply-materials/application). Complete applications require the following:

1. Application form along with paid application fee
2. Cover letter to Mathematics department including any information you believe will help process your application. Please indicate in this letter whether you are interested in a GTA position, for example
3. Transcripts (an official copy for each undergraduate institution attended. University of Louisville transcripts are automatically submitted)
4. At least two (2) letters of recommendation
5. Recent (within three years) GRE scores (only the general exam is required)
6. All applicants for whom English is a second language must also submit official TOEFL scores of 79 or higher on the internet-based test, 213 or higher on the computer-based test, or 550 or higher on the paper-based test for verification of English proficiency. English proficiency can also be met by submitting official IELTS scores of at least 6.5 overall band score from the academic module exam.

For full consideration please submit complete applications by:

**Spring admission deadline:** November 1st.

**Fall admission deadline:** March 1st.

Late applications will be considered.

## Dual Degree Program in Applied and Industrial Mathematics and Biostatistics Application Procedure

To be admitted to the program, the student is required to apply to and be accepted by both the Department of Mathematics and the Department of Bioinformatics and Biostatistics. A student seeking admission into this program must submit letters to both the Department of Mathematics and the Department of Bioinformatics and Biostatistics stating the intent to take advantage of the dual degree program, as well as their choice of the thesis or non-thesis option for the MS in Biostatistics. Students must submit two (2) recent letters of recommendation with their letter of intent. Applicants will receive written notification stating whether their admission request has been approved or disapproved.

Students currently enrolled in the PhD in Applied and Industrial Mathematics program will need to submit complete application materials to the Department of Bioinformatics and Biostatistics for admission to the MS component of the dual degree, as well as notify his/her advisor in the Department of Mathematics of the intention to enter into the dual degree program. Letters of recommendation for admission to the MS program can be taken from the letters of recommendation written for admission to the PhD program, provided they have been written sufficiently recently.

## Program Requirements Doctor of Philosophy in Applied and Industrial Mathematics

All students admitted to the program must complete the following coursework (or their approved equivalent) and other degree requirements:

Code	Title	Hours
<b>Core Courses</b>		
Select two sequences from the following:		12
MATH 621 & MATH 622	Algebra I Algebra II	

MATH 681 & MATH 682	Combinatorics and Graph Theory I Combinatorics and Graph Theory II	
MATH 601 & MATH 602	Real Analysis I Real Analysis II	
Select two sequences from the following:		12
MATH 635 & MATH 636	Mathematical Modeling I Mathematical Modeling II	
MATH 667 & MATH 668	Statistical Inference Linear Statistical Modeling	
MATH 663 & MATH 664	Theory of Probability I Theory of Probability II	
<b>Area of Specialization (see note below)</b>		18
<b>Dissertation</b>		12-18
MATH 700	Doctoral Research	
MATH 710	Doctoral Dissertation	
Minimum Total Hours		54-60

### Additional Topics and Area of Specialization

In addition to the core, an application area of 18 credit hours will be required. The courses may be in a department outside Mathematics. They will be chosen in consultation with the student's advisory committee.

### Qualifying Examinations

Students must pass three written examinations. Two of these will be chosen from the areas of Algebra, Combinatorics and Real Analysis. The third will be chosen from the areas of Mathematical Modeling, Mathematical Statistics and Probability. Normally, these will be taken within a year of completion of the core coursework. These examinations need not be taken together and each may be attempted at most twice.

### Industrial Internship

Each student, with prior approval of the Graduate Studies Director, has to complete an internship in an appropriate industrial or governmental setting, or have equivalent experience.

### Computing Project

Each student must complete an approved computer project related to the student's area of concentration.

### Candidacy Examination

Each student must pass an oral examination in the chosen area of concentration. Usually, at most two attempts at passing this examination will be permitted. Students who wish to make a third attempt must petition the Graduate Studies Committee of the department for permissions to do so.

### Dissertation

12 to 18 credit hours: A doctoral dissertation is required of each student.

## Dual Degree Program in Applied and Industrial Mathematics (PhD) and Biostatistics (MS)

### Required Courses

The required courses for the dual degree program consist of all non-overlapping core courses for both the PhD in Applied, as well as the course requirements for the MS in Biostatistics. Courses taken to satisfy

the Biostatistics component of the dual degree program can be applied to these 18 credit hours of electives which are required for the PhD in Applied and Industrial Mathematics.

Students currently enrolled in the PhD in Applied and Industrial Mathematics program will need to submit complete application materials to the Department of Bioinformatics and Biostatistics for admission to the MS component of the dual degree, as well as notify his/her advisor in the Department of Mathematics of the intention to enter into the dual degree program (see Admissions tab).

### Requirements for the PhD in Applied and Industrial Mathematics

Code	Title	Hours
<b>Core Courses</b>		
Select two sequences from the following:		12
MATH 621 & MATH 622	Algebra I Algebra II	
MATH 681 & MATH 682	Combinatorics and Graph Theory I Combinatorics and Graph Theory II	
MATH 601 & MATH 602	Real Analysis I Real Analysis II	
Select two sequences from the following:		12
MATH 635 & MATH 636	Mathematical Modeling I Mathematical Modeling II	
MATH 667 & MATH 668	Statistical Inference Linear Statistical Modeling	
MATH 663 & MATH 664	Theory of Probability I Theory of Probability II	
<b>Application Area Courses (see note below)</b>		18
<b>Dissertation</b>		12-18
MATH 700	Doctoral Research	
MATH 710	Doctoral Dissertation	
Minimum Total Hours		54-60

### Elective/Application Area Courses

18 credit hours of Application Area courses are chosen in consultation with a student's advisory committee. These courses can be outside of the Department of Mathematics. Courses taken to satisfy the Biostatistics component of the dual degree program can be approved to satisfy these 18 credit hours.

### Industrial Internship

Each student, with prior approval of the Graduate Studies Director and the Industrial Internship Director, has to complete an internship in an appropriate industrial or governmental setting, or have equivalent experience. The Industrial Internship required by the Department of Mathematics and the Master's Project or Thesis required for the MS can be satisfied by a single internship and technical report which simultaneously satisfies the requirements for both degrees. Specifically, the internship must both focus on biostatistics so that it satisfies the Project or Thesis, and contain advanced mathematical content so that it satisfies the Industrial Internship. Likewise, the technical report must meet two requirements: it must satisfy the requirements for a Master's Project report or Master's Thesis for the MS degree and it must be written at an advanced mathematical level expected Industrial Internship. Students should enroll in the Master's Project (PHST 675) or Master's Thesis (PHST 666) courses during or shortly after completion

of the Industrial Internship to take advantage of the combined Industrial Internship and Master's Project/Thesis.

Dual-degree students will not be permitted to enroll in the Master's Project (PHST 675) or Master's Thesis (PHST 666) courses until at least 2 qualifying examinations toward the PhD in Applied and Industrial Mathematics have been completed.

### Other Requirements

Students must pass qualifying examinations, complete an approved computing project, and pass a candidacy examination as detailed in the catalog entry for the PhD in Applied and Industrial Mathematics.

### Dissertation

(12-18 credit hours): In order for the student to fulfill the PhD requirements, the student must satisfy both the qualifying examination and dissertation requirements for the PhD in Applied and Industrial Mathematics. Failure to complete these requirements will not jeopardize the MS degree if all its requirements have been satisfactorily completed.

### MS in Biostatistics

Code	Title	Hours
<b>Core Course Requirements</b>		
Select one of the following sequences: <sup>1</sup>		6
PHST 661 & PHST 662	Probability Mathematical Statistics	
MATH 561 & MATH 562	Probability Mathematical Statistics	
PHST 680 & PHST 681	Biostatistical Methods I Biostatistical Methods II <sup>2</sup>	6
PHPH 523	Public Health in the United States <sup>3</sup>	2
PHST 624	Clinical Trials I: Planning and Design	2
PHST 625	Clinical Trials II	2
PHST 683	Survival Analysis	3
PHST 684	Categorical Data Analysis	3
Various Biostatistics Electives <sup>4</sup>		8
<b>Additional Requirements - Option Thesis</b>		
PHST 666	Master's Thesis Research <sup>5</sup>	6
Minimum Total Hours		38

<sup>1</sup> The PHST 661-PHST 662/MATH 561-MATH 562 requirement is waived if the student takes MATH 663 and MATH 667. The PHST 681-PHST 682 requirement is waived if the student takes MATH 667-MATH 668. Both requirements (PHST 661-PHST 662/MATH 561-MATH 562 and PHST 681-PHST 682) are waived **only if** the student completes both the MATH 663-MATH 664 and MATH 667-MATH 668 sequences.

<sup>2</sup> Courses taken to satisfy the Biostatistics component of the dual degree program can be applied to the 18 credit hours of electives which are required for the PhD in Applied and Industrial Mathematics.

<sup>3</sup> A course in public health is a requirement for any student graduating with the MS degree from the Department of Bioinformatics and Biostatistics. These credit hours are not applied to the MS degree.

<sup>4</sup> Electives are chosen in consultation with an advisor, typically from PHST 603, PHST 620, PHST 640, PHST 675, and PHST 682.

<sup>5</sup> To be completed in accordance with the guidelines written in the catalog entry for the MS in Bioinformatics and Biostatistics Degree.

### Combined Industrial Internship, Practicum and Master's Thesis (6-8 credit hours)

The Industrial Internship required by the Department of Mathematics and the Master's Project or Thesis required for the MS can be satisfied by a single internship and technical report which simultaneously satisfies the requirements for both degrees. Specifically, the internship must both focus on biostatistics so that it satisfies the Project or Thesis, and contain advanced mathematical content so that it satisfies the Industrial Internship. Likewise, the technical report must meet two requirements: it must satisfy the requirements for a Master's Project report or Master's Thesis for the MS degree and it must be written at an advanced mathematical level expected Industrial Internship. Students should enroll in the Master's Project (PHST 675) or Master's Thesis (PHST 666) courses during or shortly after completion of the Industrial Internship to take advantage of the combined Industrial Internship and Master's Project/Thesis.

Students will not be permitted to enroll in the Master's Project (PHST 675) or Thesis (PHST 666) courses until at least 2 qualifying examinations toward the PhD in Applied and Industrial Mathematics have been completed.

### Special Considerations: Students who have already completed a master's degree in the Department of Mathematics

To preserve the spirit of a dual degree, such students need to complete 36 credit hours of courses as required for the MS in Biostatistics-Decision Science. Six (6) credit hours of the previous master's degree coursework can be applied to this requirement. The remaining semester hours must be chosen from the list of not covered by core courses approved electives for the Department of Bioinformatics and Biostatistics, with preference given to courses in the Departments of Mathematics and Bioinformatics and Biostatistics. Combined Industrial Internship, Practicum and Master's Thesis cannot be replaced by a previous master's thesis. This requirement must be satisfied as previously described, meeting the specifications of both departments.