Doctor of Philosophy

Computational and Applied Mathematics (PhD)

A minimum of 78 credit hours beyond the bachelor's degree and 48 hours beyond the master's degree is required. Each student will be assigned an Advisory Committee, and together they will plan a complete program of course work designed to meet the student's objectives and to fulfill a concentration in mathematics of data science, or an option in applied mathematics, statistics, or biostatistics. The student is strongly encouraged to select courses in more than one of the concentration or option areas and in a field of application whenever such courses contribute appropriately to his or her program. Each program, however, must be directed and approved by the student's Advisory committee. A student receiving a grade of C+ or lower in any graduate course may be dismissed from the program. The concentration in Mathematics of Data Science and the three options offered under the PhD Program in Computational and Applied Mathematics are Applied Mathematics, Statistics, and Biostatistics:

- Mathematics of Data Science Concentration: Students electing the concentration in Mathematics of Data Science will pursue course work in the mathematical and statistical analysis of computational data science, including advanced machine learning, linear models, multivariate statistics, high dimensional statistics and applied functional data analytics. A PhD thesis project will bring them in contact with the research frontier.
- Applied Mathematics Option: Students electing the concentration in Applied Mathematics will pursue course work in advanced mathematical analysis, differential equations, numerical methods, transform methods, and data science. They will take electives in other methods of applied mathematics, or in an application area. A PhD thesis project will bring them in contact with the research frontier.
- Statistics Option: Students electing the concentration in Statistics will pursue course work in mathematical statistics, advanced regression analysis including responses surfaces, factorial designs, time series, advanced statistical computing. They will take electives in other areas of statistics and biostatistics. A PhD thesis project involving statistical analysis of real-life data is required.
- Biostatistics Option: Students electing the concentration in Biostatistics will pursue course work in mathematical statistics, and biostatistical methods including survival analysis, clinical trials, categorical and longitudinal data analysis. They will take electives in other areas of statistics and biostatistics. A PhD thesis project involving statistical analysis of biomedical or health care data is required.

Applicants who appear to be qualified for study at an advanced graduate level may be admitted to the doctoral program in computational and applied mathematics. These will be students with very strong backgrounds in mathematics, statistics, computer science, or application areas with a mathematics component (e.g. physics or engineering).

Students may be admitted directly to the Ph.D. program with either a bachelor's or a master's degree. A grade point average of 3.00 (4.00 scale) in the major and related mathematics courses is required.

Students are required to submit a formal application form, official transcripts, and three letters of recommendation to the Office of Admission.

Curriculum Requirements

Computational and Applied Mathematics Core

Common core courses		
MATH 617	Measure and Integration	3
STAT 626	Statistical Theory for Data Science	3
MATH 898	Research	6
or STAT 898	Research	
Dissertation credits		**18**
MATH 899	Dissertation	
or STAT 899	Dissertation	
Total Credit Hours		**30**

Applied Mathematics Option:

Select 18 credits of the following:		18
MATH 605	Complex Variables I	
MATH 618	Applied Functional Analysis	
MATH 622	Numerical Solutions to Differential Equations	
MATH 637	Tensor Calculus and Differential Geometry	
MATH 638	Mathematical Theories of Continua	
MATH 693	Engineering Analysis III	
MATH 801 & MATH 802	Asymptotic and Perturbation Methods and Integral Equations	
MATH 821 & MATH 822	Advanced Applied Numerical Methods I and Advanced Applied Numerical Methods II	
MATH 803	Advanced Applied Mathematics I	
or MATH 825	Computational Fluid Dynamics	
BDA 845	Transform Methods for Data Science	
Total Credit Hours		**18**

Biostatistics Option:

Select 18 credits of the following		18
STAT 825	Linear Statistical Models	
STAT 827	Advanced Statistical Inference I	
STAT 828	Advanced Statistical Inference II	
STAT 830	Multivariate Statistics	
STAT 840	Advanced Clinical Trials	
STAT 849	Advanced Nonparametric Statistics	
BDA 640	Genomic Data Science	
BDA 821	High-Dimensional Statistics	
BDA 831	Applied Functional Data Analysis	
Total Credit Hours		**18**

Statistics Option:

Select 18 credits of the following:		18
STAT 630	Time Series Models	
STAT 640	Survival Analysis	
STAT 825	Linear Statistical Models	
STAT 827	Advanced Statistical Inference I	
STAT 828	Advanced Statistical Inference II	
STAT 830	Multivariate Statistics	
STAT 847	Advanced Analysis of Longitudinal Data	
STAT 849	Advanced Nonparametric Statistics	
STAT 850	Advanced Categorical Data Analysis	
BDA 821	High-Dimensional Statistics	
BDA 831	Applied Functional Data Analysis	
Total Credit Hours		**18**

Additional Requirements

Colloquium Requirement

In order to develop an appreciation for the breadth of contemporary research in applied mathematics and statistics, all Ph.D. candidates will attend at least 80% and succinctly summarize and evaluate in writing at least 16

professional seminars given by research faculty or external seminar visitors. The Richard F. Barry Colloquium Series is run by the department throughout the academic year. The department also conducts seminars jointly with other departments.

Foreign Language

A foreign language is not required.

Residency Requirement

An essential feature of doctoral study is the provision of total concentration on the field of study for significant periods of time. Students who wish to pursue a part of their doctoral study on a part-time basis may do so, but all doctoral students shall spend at least two academic years engaged in full-time graduate study.

Admission to Candidacy Examination

At the end of the core mathematics or statistics course work and prior to selecting a dissertation advisor, the student must pass an Admission to Candidacy Examination designed to test scholarly competence and knowledge and to give the examiners a basis for constructive recommendations on subsequent study. The written portion of this examination will be based upon an examination syllabus that will be provided to each student. The outcome of this examination will be reported to the vice provost for graduate studies and research as passed, failed, additional work to be completed, or to be re-examined. In the event of a re-examination, the outcome must be reported as passed or failed. This decision is final. The examination must be passed at least eight months prior to the granting of the degree.

Dissertation

A doctoral dissertation representing an achievement in research and a significant contribution to the field is required. Students must register for MATH 898 or MATH 899 each semester in which they are doing substantial work on their dissertations. A minimum of 24 hours of such research credit is required.

Defense of Dissertation

This examination will be oral and must be completed at least four weeks before the date on which the degree is to be conferred. The dissertation committee members must have the completed dissertation at least two weeks before the date of the oral examination. Under normal circumstances, it is expected that the student will have had a research paper accepted for publication prior to the dissertation defense.