APPLIED AND COMPUTATIONAL MATHEMATICS, MASTER OF SCIENCE

The Applied and Computational Mathematics program is devoted to the study and development of mathematical disciplines especially oriented to the complex problems of modern society. Our curriculum emphasizes several areas of applied mathematics which have been grouped into five focus areas: Applied Analysis, Information Technology and Computation, Operations Research, Probability and Statistics, and Simulation and Modeling.

A Focus area is not required for this program. Students may choose to specialize in one of these areas, or tailor their courses to meet their individual needs.

Admission Requirements

Applicants (degree seeking and special student) must meet the general requirements for admission to graduate study, as outlined in the Admission Requirements (http://e-catalog.jhu.edu/engineering/engineering-professionals/admission-requirements/) section. The applicant's prior education must include the following prerequisites:

1. at least one mathematics course beyond multivariate calculus (such as advanced calculus, differential equations, or linear algebra); and
2. familiarity with at least one programming language (e.g., C, C++, FORTRAN, Java, Python, R, or MATLAB).

Applicants whose prior education does not include the prerequisites listed above may still be admitted under provisional status, followed by full admission once they have completed the missing prerequisites. Missing prerequisites may be completed with Johns Hopkins Engineering or, with approval, at another regionally accredited institution. In addition to these requirements, a detailed work résumé, statement of purpose, and transcripts from all college studies must be submitted. Applicants typically have earned a grade point average of at least 3.0 on a 4.0 scale (B or above) in the latter half of their undergraduate studies. When reviewing an application, the candidate's academic and professional background will be considered.

Program Requirements

Ten courses must be completed within five years. The curriculum consists of four core courses (including a two-term 700-level course sequence) and six electives. The six electives must include at least four from the program (625.xxx), with at least two of the four courses at the 700-level. Students are required to take at least one 700-level course outside of the core sequences.

Code	Title	Credits
Core Courses		
EN.625.603	Statistical Methods and Data Analysis	3
EN.625.601	Real Analysis	3
or EN.625.609	Matrix Theory	
Select one of the following sequences		
EN.625.717 & EN.625.718	Advanced Differential Equations: Partial Differential Equations and Advanced Differential Equations: Nonlinear Differential Equations and Dynamical Systems [1]	6
EN.625.721 & EN.625.722	Probability and Stochastic Process I and Probability and Stochastic Process II	6
EN.625.725 & EN.625.726	Theory Of Statistics I and Theory of Statistics II	6

[1] courses may be taken in either order

An independent study (EN.625.800 Independent Study), research project (EN.625.801 Applied and Computational Mathematics Master's Research–EN.625.802 Applied and Computational Mathematics Master's Research), or thesis (EN.625.803 Applied and Computational Mathematics Master's Thesis–EN.625.804 Applied and Computational Mathematics Master's Thesis) may be substituted for one or two of the 700-level courses outside of the 700-level core sequence. Overall, given the requirements above, at least four 700- or 800-level ACM courses (625.xxx) must be completed. A student who has taken at least one semester of graduate statistics (outside of Applied and Computational Mathematics) may substitute another 625.xxx course for EN.625.603 Statistical Methods and Data Analysis with approval of the student's advisor. The prior statistics course must be calculus-based and must cover the same general topics as EN.625.603 Statistical Methods and Data Analysis. Focus areas are not required for this program. Only one C-range grade (C+, C, or C–) can count toward the master's degree. All course selections are subject to advisor approval.

Courses

Code	Title	Credits
Undergraduate-Level Courses		
EN.625.108	Calculus I	3
EN.625.109	Calculus II	3
EN.625.201	General Applied Mathematics	3
EN.625.250	Multivariable Calculus and Complex Analysis	3
EN.625.251	Introduction to Ordinary and Partial Differential Equations	3
EN.625.252	Linear Algebra	3
EN.625.260	Introduction to Signals and Systems	3

Students may take selected courses above as desired (e.g., as a refresher) or as required via provisional admissions status. Applicants whose prior education does not include the prerequisites listed under Admission Requirements may still be admitted under provisional status, followed by full admission once they have completed the missing prerequisites. These 100- and 200-level courses are not for graduate credit, and do not count toward the degree or certificate requirements. Note that 625.250 fulfills a requirement for multivariable calculus (calculus III).

Courses by Focus Areas

The focus areas offered represent related groups of courses that are relevant for students with interests in the selected areas. The focus areas are presented as an aid to students in planning their course schedules and are generally applicable to students seeking a master's degree; the more advanced courses within each focus area may also apply to the post-master's certificate. A Focus Area can be selected, but is not

required for this program. They do not appear as official designations on a student's transcript or diploma.

Code	Title	Credits
Focus Areas		
Applied Analysis (p.)		
Information Technology and Computation (p.)		
Operations Research (p.)		
Probability and Statistics (p.)		
Simulation and Modeling (p.)		

Applied Analysis

Code	Title	Credits
EN.625.601	Real Analysis	3
EN.625.602	Modern Algebra	3
EN.625.604	Ordinary Differential Equations	3
EN.625.609	Matrix Theory	3
EN.625.611	Computational Methods	3
EN.625.680	Cryptography	3
EN.625.685	Number Theory	3
EN.625.687	Applied Topology	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.703	Complex Analysis	3
EN.625.710	Fourier Analysis with Applications to Signal Processing and Differential Equations	3
EN.625.717	Advanced Differential Equations: Partial Differential Equations	3
EN.625.718	Advanced Differential Equations: Nonlinear Differential Equations and Dynamical Systems	3
EN.625.728	Theory of Probability	3
EN.625.800	Independent Study	3
EN.625.801 & EN.625.802	Applied and Computational Mathematics Master's Research and Applied and Computational Mathematics Master's Research	6
EN.625.803 & EN.625.804	Applied and Computational Mathematics Master's Thesis and Applied and Computational Mathematics Master's Thesis	6
EN.625.805 & EN.625.806	Applied and Computational Mathematics Post-Master's Research and Applied and Computational Mathematics Post-Master's Research	6
EN.625.807 & EN.625.808	Applied and Computational Mathematics Post-Master's Thesis and Applied and Computational Mathematics Post-Master's Thesis	6

Information Technology and Computation

Code	Title	Credits
EN.625.603	Statistical Methods and Data Analysis	3
EN.625.609	Matrix Theory	3
EN.625.611	Computational Methods	3
EN.625.615	Introduction to Optimization	3
EN.625.616	Optimization in Finance	3
EN.625.617	Intro to Enumerative Combinatorics	3
EN.625.618	Discrete Hybrid Optimization	3
EN.625.623	Introduction to Operations Research: Probabilistic Models	3
EN.625.633	Monte Carlo Methods	3
EN.625.638	Neural Networks	3
EN.625.661	Statistical Models and Regression	3
EN.625.665	Bayesian Statistics	3
EN.625.680	Cryptography	3
EN.625.685	Number Theory	3
EN.625.687	Applied Topology	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.695	Time Series Analysis	3
EN.625.725	Theory Of Statistics I	3
EN.625.726	Theory of Statistics II	3
EN.625.734	Queuing Theory with Applications to Computer Science	3
EN.625.740	Data Mining	3
EN.625.743	Stochastic Optimization & Control	3
EN.625.744	Modeling, Simulation, and Monte Carlo	3
EN.625.800	Independent Study	3
EN.625.801 & EN.625.802	Applied and Computational Mathematics Master's Research and Applied and Computational Mathematics Master's Research	6
EN.625.803 & EN.625.804	Applied and Computational Mathematics Master's Thesis and Applied and Computational Mathematics Master's Thesis	6
EN.625.805 & EN.625.806	Applied and Computational Mathematics Post-Master's Research and Applied and Computational Mathematics Post-Master's Research	6
EN.625.807 & EN.625.808	Applied and Computational Mathematics Post-Master's Thesis and Applied and Computational Mathematics Post-Master's Thesis	6

Operations Research

Code	Title	Credits
EN.625.603	Statistical Methods and Data Analysis	3
EN.625.609	Matrix Theory	3
EN.625.615	Introduction to Optimization	3
EN.625.616	Optimization in Finance	3
EN.625.617	Intro to Enumerative Combinatorics	3
EN.625.618	Discrete Hybrid Optimization	3
EN.625.623	Introduction to Operations Research: Probabilistic Models	3
EN.625.633	Monte Carlo Methods	3
EN.625.636	Graph Theory	3
EN.625.641	Mathematics of Finance	3
EN.625.642	Mathematics of Risk, Options, and Financial Derivatives	3
EN.625.661	Statistical Models and Regression	3
EN.625.662	Design and Analysis of Experiments	3
EN.625.663	Multivariate Statistics and Stochastic Analysis	3

EN.625.664	Computational Statistics	3
EN.625.665	Bayesian Statistics	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.695	Time Series Analysis	3
EN.625.714	Introductory Stochastic Differential Equations with Applications	3
EN.625.721	Probability and Stochastic Process I	3
EN.625.722	Probability and Stochastic Process II	3
EN.625.725	Theory Of Statistics I	3
EN.625.726	Theory of Statistics II	3
EN.625.734	Queuing Theory with Applications to Computer Science	3
EN.625.740	Data Mining	3
EN.625.741	Game Theory	3
EN.625.743	Stochastic Optimization & Control	3
EN.625.744	Modeling, Simulation, and Monte Carlo	3
EN.625.800	Independent Study	3
EN.625.801 & EN.625.802	Applied and Computational Mathematics Master's Research and Applied and Computational Mathematics Master's Research	6
EN.625.803 & EN.625.804	Applied and Computational Mathematics Master's Thesis and Applied and Computational Mathematics Master's Thesis	6
EN.625.805 & EN.625.806	Applied and Computational Mathematics Post-Master's Research and Applied and Computational Mathematics Post-Master's Research	6
EN.625.807 & EN.625.808	Applied and Computational Mathematics Post-Master's Thesis and Applied and Computational Mathematics Post-Master's Thesis	6

Probability and Statistics

Code	Title	Credits
EN.625.603	Statistical Methods and Data Analysis	3
EN.625.617	Intro to Enumerative Combinatorics	3
EN.625.620	Mathematical Methods for Signal Processing	3
EN.625.623	Introduction to Operations Research: Probabilistic Models	3
EN.625.633	Monte Carlo Methods	3
EN.625.638	Neural Networks	3
EN.625.641	Mathematics of Finance	3
EN.625.642	Mathematics of Risk, Options, and Financial Derivatives	3
EN.625.661	Statistical Models and Regression	3
EN.625.662	Design and Analysis of Experiments	3
EN.625.663	Multivariate Statistics and Stochastic Analysis	3
EN.625.664	Computational Statistics	3
EN.625.665	Bayesian Statistics	3
EN.625.680	Cryptography	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.692	Probabilistic Graphical Models	3
EN.625.695	Time Series Analysis	3
EN.625.710	Fourier Analysis with Applications to Signal Processing and Differential Equations	3
EN.625.714	Introductory Stochastic Differential Equations with Applications	3
EN.625.721	Probability and Stochastic Process I	3
EN.625.722	Probability and Stochastic Process II	3
EN.625.725	Theory Of Statistics I	3
EN.625.726	Theory of Statistics II	3
EN.625.728	Theory of Probability	3
EN.625.734	Queuing Theory with Applications to Computer Science	3
EN.625.740	Data Mining	3
EN.625.741	Game Theory	3
EN.625.743	Stochastic Optimization & Control	3
EN.625.744	Modeling, Simulation, and Monte Carlo	3
EN.625.800	Independent Study	3
EN.625.801 & EN.625.802	Applied and Computational Mathematics Master's Research and Applied and Computational Mathematics Master's Research	6
EN.625.803 & EN.625.804	Applied and Computational Mathematics Master's Thesis and Applied and Computational Mathematics Master's Thesis	6
EN.625.805 & EN.625.806	Applied and Computational Mathematics Post-Master's Research and Applied and Computational Mathematics Post-Master's Research	6
EN.625.807 & EN.625.808	Applied and Computational Mathematics Post-Master's Thesis and Applied and Computational Mathematics Post-Master's Thesis	6

Simulation and Modeling

Code	Title	Credits
EN.625.603	Statistical Methods and Data Analysis	3
EN.625.604	Ordinary Differential Equations	3
EN.625.615	Introduction to Optimization	3
EN.625.616	Optimization in Finance	3
EN.625.618	Discrete Hybrid Optimization	3
EN.625.620	Mathematical Methods for Signal Processing	3
EN.625.623	Introduction to Operations Research: Probabilistic Models	3
EN.625.633	Monte Carlo Methods	3
EN.625.638	Neural Networks	3
EN.625.641	Mathematics of Finance	3
EN.625.642	Mathematics of Risk, Options, and Financial Derivatives	3
EN.625.661	Statistical Models and Regression	3
EN.625.662	Design and Analysis of Experiments	3
EN.625.663	Multivariate Statistics and Stochastic Analysis	3
EN.625.664	Computational Statistics	3
EN.625.665	Bayesian Statistics	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.695	Time Series Analysis	3

EN.625.714	Introductory Stochastic Differential Equations with Applications	3
EN.625.717	Advanced Differential Equations: Partial Differential Equations	3
EN.625.718	Advanced Differential Equations: Nonlinear Differential Equations and Dynamical Systems	3
EN.625.721	Probability and Stochastic Process I	3
EN.625.722	Probability and Stochastic Process II	3
EN.625.725	Theory Of Statistics I	3
EN.625.726	Theory of Statistics II	3
EN.625.728	Theory of Probability	3
EN.625.740	Data Mining	3
EN.625.741	Game Theory	3
EN.625.743	Stochastic Optimization & Control	3
EN.625.744	Modeling, Simulation, and Monte Carlo	3
EN.625.800	Independent Study	3
EN.625.801 & EN.625.802	Applied and Computational Mathematics Master's Research and Applied and Computational Mathematics Master's Research	6
EN.625.803 & EN.625.804	Applied and Computational Mathematics Master's Thesis and Applied and Computational Mathematics Master's Thesis	6
EN.625.805 & EN.625.806	Applied and Computational Mathematics Post-Master's Research and Applied and Computational Mathematics Post-Master's Research	6
EN.625.807 & EN.625.808	Applied and Computational Mathematics Post-Master's Thesis and Applied and Computational Mathematics Post-Master's Thesis	6

Electives

Two electives may be from the Applied and Computational Mathematics program or from another graduate program provided the courses have significant mathematical content. Electives from outside of the program must be approved by an advisor.

*Please refer to the course schedule (*ep.jhu.edu/schedule *(*http://ep.jhu.edu/schedule*)) published each term for exact dates, times, locations, fees, and instructors.*