DATA SCIENCE, MASTER OF SCIENCE

Admission Requirements

Applicants (degree seeking and special student) must meet the general requirements for admission (https://e-catalogue.jhu.edu/engineering/engineering-professionals/admission-requirements/) to graduate study. The applicant's prior education must include the following prerequisites:

1. Three semesters or five quarters of calculus, which includes multivariate calculus;
2. One semester/term of advanced math (discrete mathematics is strongly preferred but linear algebra or differential equations will be accepted);
3. One semester/term of Java or Python (C++ will be accepted but the student must be at least also somewhat knowledgeable in Java or Python);

Linear Algebra or Differential Equations will be accepted in lieu of Discrete Mathematics. A grade of B− or better must have been earned in each of the prerequisite courses. Applicants whose prior education does not include the prerequisites listed above may still enroll under provisional status, followed by full admission status once they have completed the missing prerequisites. Missing prerequisites may be completed with Johns Hopkins Engineering (all prerequisites are available) or at another regionally accredited institution. Admitted students 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. Applicants may submit a detailed résumé if they would like their academic and professional background to be considered.

Undergraduate courses are offered to satisfy computer science and mathematics beyond calculus requirements.

Program Requirements

Ten courses must be completed within five years. The curriculum consists of seven required courses, two Applied and Computational Mathematics (EN.625.6xx) and (EN.625.7XX) electives, at least one of which must be at the 700-level, and one Computer Science elective (EN.605.7xx) at the 700-level. Only **one** C-range grade (C+, C, or C−) can count toward the master's degree. Any grade for a course lower than a C- will not be counted toward the degree. Course selections outside of the foundational, required, and elective course lists below are subject to advisor approval.

Courses applied toward undergraduate or graduate degrees at other institutions (non-JHU) are not eligible for transfer or double counting to a Data Science master's degree or post-master's certificate. Up to two graduate courses taken outside of JHU after an undergraduate degree was conferred and not applied toward a graduate degree may be considered toward the Data Science master's degree subject to advisor approval.

Non-degree students in Data Science should consult with their advisor to determine which courses must be successfully completed before 600- or 700-level Data Science courses may be taken.

Undergraduate Courses

Code	Title	Credits
Undergraduate Courses (or approved equivalent) [1]		**Credits**
EN.605.206	Introduction to Programming Using Python	3
EN.625.250	Multivariable Calculus and Complex Analysis	3
EN.605.203	Discrete Mathematics	3
or EN.625.251	Introduction to Ordinary and Partial Differential Equations	
or EN.625.252	Linear Algebra and Its Applications	

[1] Applicants whose prior education does not include the prerequisites listed under Admission Requirements may still enroll under provisional status, followed by full admission once they have completed the missing prerequisites. All prerequisite courses beyond calculus are available at Johns Hopkins Engineering and can be found above under the Undergraduate Courses heading. These courses do not count toward the degree or certificate requirements.

Foundational Courses

Code	Title	Credits
Foundation Courses		**Credits**
EN.685.621	Algorithms for Data Science [2]	3
EN.625.603	Statistical Methods and Data Analysis [2]	3
Required Courses		**Credits**
EN.685.648	Data Science	3
EN.685.652	Data Engineering Principles and Practice	3
EN.685.662	Data Patterns and Representations	3
EN.625.661	Statistical Models and Regression	3
EN.625.615	Introduction to Optimization [3]	3
or EN.625.664	Computational Statistics	
Applied and Computational Mathematics Electives		
Select 2 of the following (One from Group 1 AND One from Group 2):		
Group 1		**Credits**
EN.625.601	Real Analysis	3
EN.625.609	Matrix Theory	3
EN.625.611	Computational Methods	3
EN.625.615	Introduction to Optimization	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.625.636	Graph Theory	3
EN.625.638	Foundations of Neural Networks	3
EN.625.641	Mathematics of Finance	3
EN.625.642	Mathematics of Risk, Options, and Financial Derivatives	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.625.687	Applied Topology	3
EN.625.690	Computational Complexity and Approximation	3

EN.625.692	Probabilistic Graphical Models	3
EN.625.695	Time Series Analysis	3
EN.625.717	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
Group 2		**Credits**
EN.625.714	Introductory Stochastic Differential Equations with Applications	3
EN.625.721	Probability and Stochastic Processes I	3
EN.625.722	Probability and Stochastic Processes 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.625.742	Theory of Machine Learning	3
EN.625.743	Stochastic Optimization & Control	3
EN.625.744	Modeling, Simulation, and Monte Carlo	3
Computer Science Electives		**Credits**
Select one of the following:		
EN.605.741	Large-Scale Database Systems	3
EN.605.742	Deep Neural Networks	3
EN.605.744	Information Retrieval	3
EN.605.745	Reasoning Under Uncertainty	3
EN.605.746	Advanced Machine Learning	3
EN.605.747	Evolutionary and Swarm Intelligence	3
EN.605.788	Big Data Processing Using Hadoop	3
EN.685.701	Data Science: Modeling and Analytics	3
EN.705.742	Advanced Applied Machine Learning	3

EN.605.633	Social Media Analytics	3
EN.605.634	Crowdsourcing and Human Computation	3
EN.605.635	Cloud Computing	3
EN.605.645	Artificial Intelligence	3
EN.605.647	Neural Networks	3
EN.605.649	Principles and Methods in Machine Learning	3
EN.605.724	Applied Game Theory	3
EN.625.601	Real Analysis	3
EN.625.609	Matrix Theory	3
EN.625.611	Computational Methods	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.625.636	Graph Theory	3
EN.625.641	Mathematics of Finance	3
EN.625.642	Mathematics of Risk, Options, and Financial Derivatives	3
EN.625.662	Design and Analysis of Experiments	3
EN.625.663	Multivariate Statistics and Stochastic Analysis	3
EN.625.665	Bayesian Statistics	3
EN.625.680	Cryptography	3
EN.625.687	Applied Topology	3
EN.625.690	Computational Complexity and Approximation	3
EN.625.692	Probabilistic Graphical Models	3
EN.625.695	Time Series Analysis	3
EN.625.717	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.705.601	Applied Machine Learning	3
Independent Study		**Credits**
EN.685.795	Capstone Project in Data Science	3
EN.685.801	Independent Study in Data Science I	3
EN.685.802	Independent Study in Data Science II	3

[2] Students must successfully complete or waive all foundational courses before enrolling in any other course.

[3] EN.625.616 Optimization in Finance may be substituted.

Students who have been waived from foundation or required courses may replace the courses with the same number of other graduate courses. EN.605.xxx courses must be replaced with EN.605.xxx courses and EN.625.xxx courses must be replaced with EN.625.xxx courses. Students who waive EN.605.641 Principles of Database Systems must replace it with EN.605.741 Large-Scale Database Systems. Students who waive EN.685.621 Algorithms for Data Science must replace it with EN.605.641 Principles of Database Systems or EN.605.649 Principles and Methods in Machine Learning. Students who take outside electives from other programs must meet the specific course prerequisites listed.

Additional Selections

Students waiving required courses may choose from the list of 700-level electives or from the courses below. The replacement course should be from the same field (EN.605.xxx or EN.625.xxx) as the waived course.

Code	Title	Credits
Additional Selections		**Credits**
EN.605.632	Graph Analytics	3

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