APPLIED MATHEMATICS AND STATISTICS, MASTER OF SCIENCE IN ENGINEERING

Students may elect to work toward the master's degree in engineering (M.S.E.) degree in applied mathematics and statistics. All master's degrees in the Department of Applied Mathematics and Statistics ordinarily require a minimum of two semesters of registration as a full-time resident graduate student.

Program Requirements

To obtain departmental certification for the master's degree in Applied Mathematics and Statistics, the student must:

1. Complete satisfactorily at least eight one-semester courses of graduate work in a coherent program approved by the faculty advisor. All 600-level and 700-level courses (with the exception of seminar and research courses), are satisfactory for this requirement. Certain courses in other departments are also acceptable, and must be approved in advance. At most 3 courses outside the department may be counted toward the Master's degree requirements. WSE courses listed as 1- or 2-credit courses count only as one-half course. Approved KSAS graduate courses count as one-half course if the number of meeting hours per week is 1 or 2 and count as a full course otherwise.

2. Meet either of the following options:
   a. submit an acceptable research report based on an approved project; or
   b. complete satisfactorily two additional one-semester graduate courses, as approved by the faculty advisor and Chair.

3. Satisfy the computing requirement by receiving a grade of B- or better in one of the following courses:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>AS.110.445</td>
<td>Mathematical and Computational Foundations of Data Science</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.600</td>
<td>Mathematical Modeling and Consulting</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.613</td>
<td>Applied Statistics and Data Analysis</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.632</td>
<td>Bayesian Statistics</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.633</td>
<td>Monte Carlo Methods</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.636</td>
<td>Introduction to Data Science</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.650</td>
<td>Computational Molecular Medicine</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.681</td>
<td>Numerical Analysis</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.688</td>
<td>Computing for Applied Mathematics</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.693</td>
<td>Mathematical Image Analysis</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.740</td>
<td>Machine Learning I</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.743</td>
<td>Graphical Models</td>
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<tr>
<td>EN.553.753</td>
<td>Commodity Markets and Trade Finance</td>
<td>4</td>
</tr>
<tr>
<td>EN.553.761</td>
<td>Nonlinear Optimization I</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.762</td>
<td>Nonlinear Optimization II</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.763</td>
<td>Stochastic Search &amp; Optimization</td>
<td>3</td>
</tr>
<tr>
<td>EN.553.765</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EN.553.780</td>
<td>Shape and Differential Geometry</td>
<td></td>
</tr>
</tbody>
</table>

4. Complete an area of focus by taking three courses in one of the following areas. A list of courses that can be counted toward each area of focus will be maintained and updated every year. Some courses from other departments can be eligible to count toward the area of focus. They can be used within the three-course limit specified in point 1, above. This list of courses is based on recent offerings. Not all classes are available every year and substitute classes may be accepted if approved by the advisor and the Academic Affairs Committee.

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<tr>
<th>Code</th>
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</thead>
<tbody>
<tr>
<td>EN.601.675</td>
<td>Machine Learning</td>
<td>3</td>
</tr>
<tr>
<td>EN.601.682</td>
<td>Machine Learning: Deep Learning</td>
<td>4</td>
</tr>
</tbody>
</table>

Select three courses in one of the following areas:

- **Probability Theory**
  - AS.110.445 Mathematical and Computational Foundations of Data Science
  - EN.553.626 Introduction to Stochastic Processes
  - EN.553.627 Stochastic Processes and Applications to Finance
  - EN.553.628 Stochastic Processes and Applications to Finance II
  - EN.553.633 Monte Carlo Methods
  - EN.553.720 Probability Theory I
  - EN.553.721 Probability Theory II
  - EN.553.722 Introduction to Stochastic Calculus
  - EN.553.763 Stochastic Search & Optimization
  - EN.553.764 Modeling, Simulation, and Monte Carlo

- **Statistics and Statistical Learning**
  - AS.110.445 Mathematical and Computational Foundations of Data Science
  - EN.553.602 Research and Design in Applied Mathematics: Data Mining
  - EN.553.613 Applied Statistics and Data Analysis
  - EN.553.614 Applied Statistics and Data Analysis II
  - EN.553.632 Bayesian Statistics
  - EN.553.636 Introduction to Data Science
  - EN.553.639 Time Series Analysis
  - EN.553.650 Computational Molecular Medicine
  - EN.553.730 Statistical Theory
  - EN.553.731 Statistical Theory II
  - EN.553.733 Nonparametric Bayesian Statistics
  - EN.553.737 Distribution-free statistics and Resampling Methods
  - EN.553.739 Statistical Pattern Recognition Theory & Methods
  - EN.553.740 Machine Learning I
  - EN.553.742 Statistical Inference on Graphs
  - EN.553.782 Statistical Uncertainty Quantification

- **Optimization and Operations Research**
  - EN.553.600 Mathematical Modeling and Consulting
  - EN.553.661 Optimization in Finance
  - EN.553.653 Mathematical Game Theory
  - EN.553.663 Network Models in Operations Research
  - EN.553.665 Introduction to Convexity
EN.553.667 Deep Learning in Discrete Optimization
EN.553.761 Nonlinear Optimization I
EN.553.762 Nonlinear Optimization II
EN.553.763 Stochastic Search & Optimization
EN.553.765
EN.553.766 Combinatorial Optimization
EN.553.769 Topics in Discrete Optimization
EN.553.797 Introduction to Control Theory and Optimal Control

Computational and Applied Mathematics
AS.110.445 Mathematical and Computational Foundations of Data Science
EN.553.681 Numerical Analysis
EN.553.688 Computing for Applied Mathematics
EN.553.692 Mathematical Biology
EN.553.693 Mathematical Image Analysis
EN.553.780 Shape and Differential Geometry
EN.553.784 Mathematical Foundations of Computational Anatomy
EN.553.792 Matrix Analysis and Linear Algebra
EN.553.793 Turbulence Theory
EN.553.795 Advanced Parameterization in Science and Engineering

Discrete Mathematics
Select at least one of the following: ¹
EN.553.671 Combinatorial Analysis
EN.553.672 Graph Theory
EN.553.766 Combinatorial Optimization
Additional Options:
EN.601.631 Theory of Computation
EN.601.633 Intro Algorithms
EN.601.634 Randomized and Big Data Algorithms
EN.601.635 Approximation Algorithms

5. Students in the AMS MSE program must pass one of the EN.553.801 Department Seminar seminar sections in at least one semester. (Students are encouraged to register in multiple semesters.)

6. Complete training on the responsible and ethical conduct of research. Please see WSE Policy on the Responsible Conduct of Research (https://engineering.jhu.edu/wse-research/resources-policies-forms/responsible-conduct-of-research/).

7. Complete training on academic ethics.

¹ The Discrete Mathematics area of focus requires a minimum of one Applied Mathematics and Statistics course (listed in the first section), but the other two courses may include other listed Applied Mathematics and Statistics offerings or the listed Computer Science offerings. The Computer Science courses can be used within the three-course limit specified in point 1, above.

An overall GPA of 3.0 must be maintained in courses used to meet the program requirements. At most two course grades of C or C+ are allowed to be used and the rest of the course grades must be B- or better.

Each candidate for the master’s degree must submit to the department for approval a written program stating how they plan to meet their degree requirements. This should be done early in the first semester of residence.

Doctoral students in other departments may concurrently undertake a master’s program in Applied Mathematics and Statistics with the permission of the AMS department through an application review. Application information is available on the department website (http://engineering.jhu.edu/ams/).