Applied Mathematics-Computer Science

The Sc.B. concentration in Applied Math-Computer Science provides a foundation of basic concepts and methodology of mathematical analysis and computation and prepares students for advanced work in applied mathematics, computer science, and data science. Concentrators must complete courses in mathematics, applied math, computer science, and an approved English writing course. While the concentration in Applied Math-Computer Science allows students to develop the use of quantitative methods in thinking about and solving problems, knowledge that is valuable in all walks of life, students who have completed the concentration have pursued graduate study, computer consulting and information industries, and scientific and statistical analysis careers in industry or government. This degree offers a standard track and a professional track.


Prerequisites – the equivalent of two semesters of single-variable calculus

A second semester of single-variable calculus is not an enforced requirement for our concentration, but it is a required prerequisite for many of our courses. At Brown, the second semester of calculus is taught in one of MATH 0100, MATH 0170, or MATH 0190.

Requirements – 17 courses

Completion of one APMA pairing

Mathematical Requirements – 8 courses

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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<tbody>
<tr>
<td>MATH 0180</td>
<td>Multivariable Calculus</td>
<td>1</td>
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<tr>
<td>or MATH 0200</td>
<td>Multivariable Calculus (Physics/Engineering)</td>
<td>1</td>
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<tr>
<td>or MATH 0350</td>
<td>Multivariable Calculus With Theory</td>
<td>1</td>
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<tr>
<td>MATH 0520</td>
<td>Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>or MATH 0540</td>
<td>Linear Algebra With Theory</td>
<td>1</td>
</tr>
<tr>
<td>or CSCI 0530</td>
<td>Coding the Matrix: An Introduction to Linear Algebra for Computer Science</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 1170</td>
<td>Introduction to Computational Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>APMA 0350</td>
<td>Applied Ordinary Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>APMA 0360</td>
<td>Applied Partial Differential Equations</td>
<td>1</td>
</tr>
<tr>
<td>APMA 1160</td>
<td>An Introduction to Numerical Optimization</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 1170</td>
<td>Introduction to Computational Linear Algebra</td>
<td>1</td>
</tr>
<tr>
<td>or APMA 1180</td>
<td>Introduction to Numerical Solution of Differential Equations</td>
<td>1</td>
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<tr>
<td>or APMA 1690</td>
<td>Computational Probability and Statistics</td>
<td>1</td>
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<tr>
<td>or APMA 1740</td>
<td>Recent Applications of Probability and Statistics</td>
<td>1</td>
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Two approved 1000-level or higher APMA courses. The APMA pairing must be completed.

One 1000-level or higher APMA or MATH course

Computer Science Requirements – 8 courses

Select one of the following introductory course sequences

<table>
<thead>
<tr>
<th>Course Code</th>
<th>Course Name</th>
<th>Credits</th>
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</thead>
<tbody>
<tr>
<td>CSCI 0150 &amp; CSCI 0200</td>
<td>Introduction to Object-Oriented Programming and Computer Science and Program Design with Data Structures and Algorithms</td>
<td>2</td>
</tr>
<tr>
<td>CSCI 0170 &amp; CSCI 0200</td>
<td>Computer Science: An Integrated Introduction and Program Design with Data Structures and Algorithms</td>
<td>2</td>
</tr>
<tr>
<td>CSCI 0111 &amp; CSCI 0200</td>
<td>Computing Foundations: Data and Program Design with Data Structures and Algorithms</td>
<td>2</td>
</tr>
<tr>
<td>CSCI 0190 and one CSCI course numbered 0200 or higher</td>
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<td>1</td>
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One course in each of the following four clusters:

a. Algorithms/Theory Foundations
   - CSCI 0500 Data Structures, Algorithms, and Intractability: An Introduction
   - CSCI 1010 Theory of Computation
   - CSCI 1550 Probabilistic Methods in Computer Science
   - CSCI 1570 Design and Analysis of Algorithms

b. AI/Machine Learning/Data Science Foundations
   - CSCI 1410 Artificial Intelligence
   - CSCI 1420 Machine Learning
   - CSCI 1430 Computer Vision
   - CSCI 1460 Computational Linguistics
   - CSCI 1470 Deep Learning
   - CSCI 1850 Deep Learning in Genomics
   - CSCI 1951R Introduction to Robotics

c. Systems Foundations
   - CSCI 0300 Fundamentals of Computer Systems
   - CSCI 0330 Introduction to Computer Systems

d. Math Foundations
   - APMA 1650 Statistical Inference I
   - APMA 1450 Advanced Introduction to Probability for Computing and Data Science
   - CSCI 1210 Probability
   - APMA 2610 or another APMA/MATH course that features probability

Three approved 1000-level or higher CSCI courses, which cannot include arts/policy/humanities courses

Additional Requirements – 1 course

One approved capstone in computer science or applied mathematics taken in the student’s senior year.

Total Credits 17

1 A required course may be replaced by a more advanced course with concentration advisor approval. No course may be used to satisfy more than one of the required 17 concentration credits. Transfer credits and courses receiving placement credit notation can satisfy concentration credit as long as they appear on the Brown internal transcript. At most 3 post-matriculation transfer credits (such as study abroad courses or summer courses at another institution) can be used for concentration credit. Pursuing honors will require 18 courses – these 17 along with two semesters of independent study courses for the honors research project, one of which can be used to satisfy the capstone concentration requirement. For students with multiple concentrations: calculus, linear algebra, one intro CSCI course, and at most two additional courses can be used for concentration credit in the other concentration(s).

2 Students who take the CSCI 0111, CSCI 0112, CSCI 0200 sequence will effectively need an additional course (CSCI 0112) to complete the concentration. Students wishing to go directly from CSCI 0111 to CSCI 0200 (without CSCI 0112) will need to successfully complete additional exercises to receive an instructor override code for CSCI 0200.

3 To complete an APMA pairing, students must complete two 1000-level or higher APMA courses that adhere to a common theme. These courses can appear anywhere in the declaration. APMA 1910, APMA 1920 and research/independent study courses are not allowed. Themes can be broadly defined and are subject to concentration advisor approval. Examples include:
   - Probability and statistics: APMA 1080, APMA 1200, APMA 1650/APMA 1655, APMA 1660, APMA 1690, APMA 1710, APMA 1720, APMA 1740/APMA 2610, APMA 1860, APMA 1930V, APMA 1930W, APMA 1941D, APMA 2630, APMA 2640, APMA 2670, APMA 2680
   - Discrete and dynamical systems: APMA 1070, APMA 1180, APMA 1330, APMA 1360, APMA 1930P, APMA 2070, APMA 2190, APMA 2200, APMA 2550, APMA 2560, APMA 2570, APMA 2580B
Professional Tracks

The requirements for the professional tracks include all those of each of the standard tracks, as well as the following:

Students must complete full-time professional experiences doing work that is related to their concentration programs, totaling 2-6 months, whereby each internship must be at least one month in duration in cases where students choose to do more than one internship experience. Such work is normally done at a company, but may also be at a university under the supervision of a faculty member. Internships that take place between the end of the fall and the start of the spring semesters cannot be used to fulfill this requirement.

On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience, to be approved by the student's concentration advisor, addressing these questions:

- Which courses were put to use in your summer's work? Which topics, in particular, were important?
- In retrospect, which courses should you have taken before embarking on your summer experience? What are the topics from these courses that would have helped you over the summer if you had been more familiar with them?
- Are there topics you should have been familiar with in preparation for your summer experience, but are not taught at Brown? What are these topics?

Honors

Concentrators that demonstrate excellence in grades and in undergraduate research can be awarded departmental honors. Honors students with primary advisors in Applied Math should follow the guidelines, requirements, and deadlines for honors as described in the bulletin for Applied Math concentrators (https://bulletin.brown.edu/the-college/concentrations/apma/) and as published on the APMA departmental website (https://appliedmath.brown.edu/academics/undergraduate-program/honors/). Honors students with primary advisors in Computer Science should follow the guidelines, requirements, and deadlines for honors as described in the bulletin for Computer Science concentrators (https://bulletin.brown.edu/the-college/concentrations/comp/) and as published on the CS departmental website (https://cs.brown.edu/undergrad/concentrating-in-sc/). Students wishing to do honors research with a non-APMA or CS advisor should contact the Directors of Undergraduate Studies in APMA and CS to discuss options.