

# 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.

## Standard Program for the Sc.B. degree.

### 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 <sup>1</sup>

#### Mathematical Requirements – 8 courses

MATH 0180	Multivariable Calculus <sup>2</sup>	1
or MATH 0200	Multivariable Calculus (Physics/Engineering)	
or MATH 0350	Multivariable Calculus With Theory	
MATH 0520	Linear Algebra <sup>2</sup>	1
or MATH 0540	Linear Algebra With Theory	
or CSCI 0530	Coding the Matrix: An Introduction to Linear Algebra for Computer Science	
or APMA 1170	Introduction to Computational Linear Algebra	
APMA 0355	Applied Ordinary Differential Equations with Theory <sup>3</sup>	1
APMA 0365	Applied Partial Differential Equations I with Theory <sup>4</sup>	1
APMA 1160	An Introduction to Numerical Optimization	1
or APMA 1170	Introduction to Computational Linear Algebra	
or APMA 1180	Introduction to Numerical Solution of Differential Equations	
or APMA 1690	Computational Probability and Statistics	
or APMA 1740	Recent Applications of Probability and Statistics	
Two approved 1000-level or higher APMA courses. <sup>5,6</sup>		2
One 1000-level or higher APMA or MATH course <sup>5,6</sup>		1

#### Computer Science Requirements – 8 courses

Select one of the following introductory course sequences:		
CSCI 0150 & CSCI 0200	Introduction to Object-Oriented Programming and Computer Science and Program Design with Data Structures and Algorithms	2
CSCI 0170 & CSCI 0200	Computer Science: An Integrated Introduction and Program Design with Data Structures and Algorithms	2
CSCI 0111 & CSCI 0200	Computing Foundations: Data and Program Design with Data Structures and Algorithms <sup>7</sup>	2
CSCI 0190 and one CSCI course numbered 0200 or higher		

Select one foundational course in each of three of the following four clusters: 3

1. Algorithms/Theory	
CSCI 0500	Data Structures, Algorithms, and Intractability: An Introduction
2. AI/Machine Learning/Data Science	
CSCI 0410	Foundations of AI
3. Systems	
CSCI 0300	Fundamentals of Computer Systems <sup>8</sup>
or CSCI 0320	Introduction to Software Engineering
or CSCI 0330	Introduction to Computer Systems
4. Probability	
APMA 1655	Introduction to Probability and Statistics with Theory <sup>6,9</sup>
or APMA 1650	Introduction to Probability and Statistics with Calculus
or CSCI 1450	Advanced Introduction to Probability for Computing and Data Science
or MATH 1210	Probability
or MATH 1610	Probability

Three approved 1000-level or higher CSCI courses, which must be technical CS courses. <sup>10</sup> 3

### Additional Requirements – 1 course 1

One approved capstone in computer science or applied mathematics taken in the student's senior year. <sup>11</sup>

**Total Credits 17**

- <sup>1</sup> 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).
- <sup>2</sup> APMA 0260 can substitute for the multivariable calculus and/or the linear algebra requirements. If it is used as a substitute for both requirements, then students must take one additional approved 1000-level APMA or MATH course not used elsewhere for concentration credit. Footnotes 5 and 6 apply.
- <sup>3</sup> MATH 1110 may be used in place of APMA 0355. If MATH 1110 is used, then the concentration must include at least four 1000-level APMA courses (not including APMA 1910, 1920 or research/independent study courses; footnote 5 applies). These can appear anywhere in the declaration. Students matriculating prior to Fall 2025 can use APMA 0330 or APMA 0350 as a substitute for APMA 0355. Students matriculating in Fall 2025 or later who wish to use APMA 0330 or APMA 0350 must also complete the APMA 0355 online bridgework course and pass the in-person bridgework exam that is offered once per semester.
- <sup>4</sup> MATH 1120 may be used in place of APMA 0365. If MATH 1120 is used, then the concentration must include at least four 1000-level APMA courses (not including APMA 1910, 1920 or research/independent study courses). These can appear anywhere in the declaration. Students matriculating prior to Fall 2025 can use APMA 0340 or APMA 0360 as a substitute for APMA 0365. Students matriculating in Fall 2025 or later who wish to use APMA 0340 or APMA 0360 must also complete the APMA 0365 online bridgework course and pass the in-person bridgework exam that is offered once per semester.
- <sup>5</sup> APMA 1650 cannot be used to satisfy this requirement for students matriculating in Fall 2025 or later, unless they also complete the APMA 1655 online bridgework course and pass the in-person bridgework exam that is offered once per semester. APMA 1910, 1920, MATH 1090, 1910

and research/independent study courses are not allowed. At most one of APMA 1001, MATH 1000, MATH 1001 can be used for concentration credit.

<sup>6</sup> At most one of APMA 1650, APMA 1655, CSCI 1450, MATH 1210, MATH 1610 can be used for concentration credit.

<sup>7</sup> Students wishing to go directly from CSCI 0111 to CSCI 0200 will need to successfully complete additional exercises to receive an instructor override code for CSCI 0200.

<sup>8</sup> At most one of CSCI 0300, CSCI 0330 can be used for concentration credit.

<sup>9</sup> APMA 1655 is recommended. Higher-level courses in probability can satisfy this requirement with concentration advisor approval. The following courses are automatically approved: APMA 1080, APMA 1200, APMA 1660, APMA 1690, APMA 1710, APMA 1740/ APMA 2610, APMA 2630, APMA 2640.

<sup>10</sup> Non-CSCI courses and CS art/ humanities/policy courses cannot be used for concentration credit even if they are allowed as part of a pure CS concentration. This list is maintained in the CS concentration handbook at this link (<https://cs.brown.edu/degrees/undergrad/concentrating-in-cs/concentration-handbook/>). At most one of the electives can be an independent study course (such as CSCI 1970, CSCI 1973). At most one of CSCI 0410, CSCI 1410, CSCI 1411 can be used for concentration credit. EEPS 1340 is a non-CSCI course that can be used as a CSCI elective, but at most one of EEPS 1340 and CSCI 1951A can be used for concentration credit.

<sup>11</sup> Completing a capstone during the junior year might be allowed in exceptional cases for which completion during the senior year is impossible, such as the student's faculty research mentor not being on campus during the student's senior year, but this requires prior approval from the concentration advisor and the Director of Undergraduate Studies in CS. The following options can be used to satisfy this requirement:

(a) A pre-approved course that satisfies the APMA Sc.B. capstone requirement: currently APMA 1360, APMA 193\*/194\* (where \* is any combination of numbers and letters; these are the APMA senior seminars).

(b) Completion of a CS capstone as described in the CS Concentration Handbook at this link (<https://cs.brown.edu/degrees/undergrad/concentrating-in-cs/concentration-handbook/>). Usually, this involves taking one of the approved CS capstone courses at this link (<https://cs.brown.edu/degrees/undergrad/concentrating-in-cs/concentration-requirements-2020/capstone/>) and registering the capstone with the instructor of the course and with the CS department using the form linked at the top of the CS capstone courses page. Depending on the course it may require the completion of an additional project.

(c) A directed research/independent study course from the APMA 1970/1971 or CSCI 1970/1973 series that is used for undergraduate research. For students pursuing honors in APMA-CS, one of the two required semesters of independent study courses can be used.

(d) A directed research/independent study course in a related discipline (i.e. STEM disciplines, ENVS, PHP, etc.) that is used for undergraduate research if the project is relevant to the student's learning goals in the concentration and with approval from the concentration advisor.

(e) An upper-level course related to the concentration (usually a 1000-level or higher APMA, CSCI, or MATH course) in addition to a research experience equivalent in scope and scale to work the student would pursue in an Applied Math and Computer Science research-related independent study course. Examples include UTRAs, LINK awards, REUs, research programs at other institutions, the APMA Directed Reading Program, etc. This requires approval from the concentration advisor and appropriate documentation that should be uploaded to ASK. The research experience must be completed during the student's senior year or the summer before the student's senior year. Exceptions require prior approval from the concentration advisor and the Director of Undergraduate Studies in CS.

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?
- What did you learn from the experience that probably could not have been picked up from course work?
- Is the sort of work you did over the summer something you would like to continue doing once you graduate? Explain.
- Would you recommend your summer experience to other Brown students? Explain.
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## 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/degrees/undergrad/concentrating-in-cs/honors/>). 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.

## Professional Tracks

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