Applied Mathematics-Economics

The Applied Mathematics-Economics concentration is designed to reflect the mathematical and statistical nature of modern economic theory and empirical research. This concentration has two tracks. The first is the advanced economics track, which is intended to prepare students for graduate study in finance, and for careers in finance or financial engineering. Both tracks have A.B. degree versions and Sc.B. degree versions, as well as a Professional track option.

Standard Program for the A.B. degree (Advanced Economics track):

Prerequisites:
- MATH 0100: Introductory Calculus, Part II
- MATH 0520: Linear Algebra

Course Requirements: Applied Mathematics Requirements
(a) 1

Select one of the following: 1
- APMA 0160: Introduction to Scientific Computing (preferred)
- APMA 0200: Introduction to Modelling
- CSCI 0111: Computing Foundations: Data
- CSCI 0150: Introduction to Object-Oriented Programming and Computer Science
- CSCI 0170: Computer Science: An Integrated Introduction
- CSCI 0190: Accelerated Introduction to Computer Science

Select one of the following: 1
- or APMA 1210: Operations Research: Deterministic Models

Select one of the following: 1
- APMA 1650: Statistical Inference I
- or APMA 1655: Honors Statistical Inference I

(b) 1
Select one of the following: 1
- APMA 1160: An Introduction to Numerical Optimization
- APMA 1180: Introduction to Numerical Solution of Differential Equations
- APMA 1210: Operations Research: Deterministic Models
- APMA 1330: Applied Partial Differential Equations II
- APMA 1360: Applied Dynamical Systems
- APMA 1660: Statistical Inference II
- APMA 1690: Computational Probability and Statistics
- APMA 1670: Statistical Analysis of Time Series
- APMA 1680: Nonparametric Statistics
- APMA 1690: Computational Probability and Statistics
- APMA 1710: Information Theory
- APMA 1720: Monte Carlo Simulation with Applications to Finance

Economics Requirements: 3
- ECON 1130: Intermediate Microeconomics (Mathematical)
- ECON 1210: Intermediate Macroeconomics
- ECON 1630: Mathematical Econometrics I

Two 1000-level courses from the "mathematical-economics" group: 2
- ECON 1225: Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
- ECON 1255: Unemployment: Models and Policies
- ECON 1470: Bargaining Theory and Applications
- ECON 1490: Designing Internet Marketplaces
- ECON 1545: Topics in Macroeconomics, Development and International Economics
- ECON 1640: Mathematical Econometrics II
- ECON 1660: Big Data
- ECON 1670: Advanced Topics in Econometrics
- ECON 1680: Machine Learning, Text Analysis, and Economics
- ECON 1750: Investments II
- ECON 1805: Economics in the Laboratory
- ECON 1820: Theory of Behavioral Economics
- ECON 1850: Theory of Economic Growth
- ECON 1860: The Theory of General Equilibrium
- ECON 1870: Game Theory and Applications to Economics
- ECON 1875: Corporate Finance

One 1000-level course from the "data methods" group: 4
- ECON 1301: Economics of Education I
- ECON 1310: Labor Economics
- ECON 1315: Health, Education, and Social Policy
- ECON 1340: Economics of Global Warming
- ECON 1355: Environmental Issues in Development Economics
- ECON 1360: Health Economics
- ECON 1375: Inequality of Opportunity in the US
- ECON 1400: The Economics of Mass Media
- ECON 1430: The Economics of Social Policy
- ECON 1480: Public Economics
- ECON 1510: Economic Development
- ECON 1530: Health, Hunger and the Household in Developing Countries
- ECON 1629: Applied Research Methods for Economists
- ECON 1640: Mathematical Econometrics II
- ECON 1660: Big Data
- ECON 1670: Advanced Topics in Econometrics
- ECON 1680: Machine Learning, Text Analysis, and Economics
- ECON 1825: Behavioral Economics and Public Policy
- ECON 1830: Behavioral Finance

Total Credits 13

1 No course may be used to simultaneously satisfy (a) and (b).
Standard program for the Sc.B. degree
(Advanced Economics track):

Prerequisites:

- MATH 0100: Introductory Calculus, Part II
- MATH 0520: Linear Algebra

Course Requirements:

Applied Mathematics Requirements

(a) 1

<table>
<thead>
<tr>
<th>Course</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>APMA 0350 &amp; APMA 0360</td>
<td>Applied Ordinary Differential Equations and Applied Partial Differential Equations I 2</td>
</tr>
</tbody>
</table>

Select one of the following:

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<td>Computing Foundations: Data</td>
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<td>CSCI 0190</td>
<td>Accelerated Introduction to Computer Science</td>
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<td>CSCI 0150</td>
<td>Introduction to Object-Oriented Programming and Computer Science</td>
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<td>CSCI 0170</td>
<td>Computer Science: An Integrated Introduction</td>
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<table>
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<tbody>
<tr>
<td>APMA 1200</td>
<td>Operations Research: Probabilistic Models</td>
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<tr>
<td>APMA 1210</td>
<td>Operations Research: Deterministic Models</td>
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<tr>
<td>APMA 1650</td>
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<td>APMA 1655</td>
<td>Honors Statistical Inference I</td>
</tr>
</tbody>
</table>

(b) 1

Select two of the following:

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<td>An Introduction to Numerical Optimization</td>
</tr>
<tr>
<td>APMA 1180</td>
<td>Introduction to Numerical Solution of Differential Equations</td>
</tr>
<tr>
<td>APMA 1200</td>
<td>Operations Research: Probabilistic Models</td>
</tr>
<tr>
<td>APMA 1210</td>
<td>Operations Research: Deterministic Models</td>
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<tr>
<td>APMA 1330</td>
<td>Applied Partial Differential Equations II</td>
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<td>APMA 1360</td>
<td>Applied Dynamical Systems</td>
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<tr>
<td>APMA 1660</td>
<td>Statistical Inference II</td>
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<tr>
<td>APMA 1670</td>
<td>Statistical Analysis of Time Series</td>
</tr>
<tr>
<td>APMA 1680</td>
<td>Nonparametric Statistics</td>
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<tr>
<td>APMA 1690</td>
<td>Computational Probability and Statistics</td>
</tr>
<tr>
<td>APMA 1710</td>
<td>Information Theory</td>
</tr>
<tr>
<td>APMA 1720</td>
<td>Monte Carlo Simulation with Applications to Finance</td>
</tr>
<tr>
<td>APMA 1740</td>
<td>Recent Applications of Probability and Statistics</td>
</tr>
<tr>
<td>APMA 1860</td>
<td>Graphs and Networks</td>
</tr>
</tbody>
</table>

Economics Requirements:

- ECON 1130: Intermediate Microeconomics (Mathematical) 3
- ECON 1210: Intermediate Macroeconomics
- ECON 1630: Mathematical Econometrics I
- ECON 1640: Mathematical Econometrics II
- ECON 1660: Big Data
- ECON 1670: Advanced Topics in Econometrics
- ECON 1680: Machine Learning, Text Analysis, and Economics
- ECON 1690: The Theory of Behavior, and Applications to Economics
- ECON 1750: Investments II
- ECON 1805: Economics in the Laboratory
- ECON 1820: Theory of Behavioral Economics
- ECON 1850: Theory of Economic Growth
- ECON 1860: The Theory of General Equilibrium
- ECON 1870: Game Theory and Applications to Economics
- ECON 1875: Advanced Topics in Econometrics

One 1000-level course from the "data methods" group: 4 1

- ECON 1301: Economics of Education I
- ECON 1310: Labor Economics
- ECON 1315: Health, Education, and Social Policy
- ECON 1330: Economics of Global Warming
- ECON 1355: Environmental Issues in Development Economics
- ECON 1360: Health Economics
- ECON 1375: Inequality of Opportunity in the US
- ECON 1400: The Economics of Mass Media
- ECON 1430: The Economics of Social Policy
- ECON 1480: Public Economics
- ECON 1510: Economic Development
- ECON 1530: Health, Hunger, and the Household in Developing Countries
- ECON 1629: Applied Research Methods for Economists
- ECON 1640: Mathematical Econometrics II
- ECON 1660: Big Data
- ECON 1670: Advanced Topics in Econometrics
- ECON 1680: Machine Learning, Text Analysis, and Economics
- ECON 1825: Behavioral Economics and Public Policy
- ECON 1830: Behavioral Finance

Two additional 1000-level economics courses 5 2

Total Credits 16

1 No course may be used to simultaneously satisfy (a) and (b).
2 APMA 0330 and APMA 0340 may be substituted with advisor approval, but these are no longer being offered.
3 Or ECON 1110 with permission. For students matriculating at Brown in Fall 2021 or later, note that if ECON 1110 is used, then one additional course from the mathematical-economics group will be required.
4 No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.
5 Note that ECON 1620, ECON 1960, and ECON 1970 (independent study) cannot be used for concentration credit. However, 1620 and 1960 can be used for university credit and up to two 1970s may be used for university credit.
6 Requires written approval of the Director of Undergraduate Studies in Economics. APMA 1910 is not permitted.
3 Or ECON 1110 with permission. For students matriculating at Brown in Fall 2021 or later, note that if ECON 1110 is used, then one additional course from the mathematical-economics group will be required.

4 No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.

5 Students may apply, at most, one Economics course whose number is in the range of 1000 to 1099 toward the concentration. Note that ECON 1620, ECON 1960, and ECON 1970 (independent study) cannot be used for concentration credit. However, 1620 and 1960 can be used for university credit and up to two 1970s may be used for university credit.

6 Requires written approval of the Director of Undergraduate Studies in Economics. APMA 1910 is not permitted.

**Standard program for the A.B. degree**

**(Mathematical Finance track):**

**Prerequisites:**

- MATH 0100  Introductory Calculus, Part II
- MATH 0520  Linear Algebra

**Course Requirements:** 13 Courses: 6 Applied Math and 7 Economics

**Applied Mathematics Requirements**

**(a)**

1. APMA 0350 & APMA 0360  Applied Ordinary Differential Equations and Applied Partial Differential Equations 2

Select one of the following:

- APMA 0160  Introduction to Scientific Computing (preferred)
- APMA 0200  Introduction to Modelling
- CSCI 0111  Computing Foundations: Data
- CSCI 0150  Introduction to Object-Oriented Programming and Computer Science
- CSCI 0170  Computer Science: An Integrated Introduction
- CSCI 0190  Accelerated Introduction to Computer Science
- APMA 1200  Operations Research: Probabilistic Models 1
- APMA 1650  Statistical Inference I 1
- or APMA 1655  Honors Statistical Inference I

**(b)**

Select one of the following:

- APMA 1160  An Introduction to Numerical Optimization
- APMA 1180  Introduction to Numerical Solution of Differential Equations
- APMA 1210  Operations Research: Deterministic Models
- APMA 1330  Applied Partial Differential Equations II
- APMA 1360  Applied Dynamical Systems
- APMA 1660  Statistical Inference II
- APMA 1670  Statistical Analysis of Time Series
- APMA 1680  Nonparametric Statistics
- APMA 1690  Computational Probability and Statistics
- APMA 1710  Information Theory
- APMA 1720  Monte Carlo Simulation with Applications to Finance (preferred)
- APMA 1740  Recent Applications of Probability and Statistics
- APMA 1860  Graphs and Networks
- MATH 1010  Analysis: Functions of One Variable
- APMA 193X, 194X Senior Seminar series, depending on topic

**Economics Requirements:**

<table>
<thead>
<tr>
<th>Course</th>
<th>Title</th>
<th>Credit</th>
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<tbody>
<tr>
<td>ECON 1130</td>
<td>Intermediate Microeconomics (Mathematical) 1</td>
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<td>ECON 1210</td>
<td>Intermediate Macroeconomics</td>
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<td>ECON 1630</td>
<td>Mathematical Econometrics I</td>
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<td>Select two 1000-level courses from the &quot;financial economics&quot; group: 2</td>
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<tr>
<td>ECON 1710</td>
<td>Investments I</td>
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<td>ECON 1720</td>
<td>Corporate Finance</td>
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<td>ECON 1730</td>
<td>Venture Capital, Private Equity, and Entrepreneurship</td>
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<td>Investments II</td>
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<td>ECON 1760</td>
<td>Financial Institutions</td>
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<tr>
<td>ECON 1780</td>
<td>Advanced Topics in Corporate Finance</td>
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<td>ECON 1830</td>
<td>Behavioral Finance</td>
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<td>Select one 1000-level course from the &quot;mathematical economics&quot; group: 1</td>
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<td>Welfare Economics and Social Choice Theory</td>
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<td>Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies</td>
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<td>ECON 1805</td>
<td>Economics in the Laboratory</td>
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<td>Theory of Economic Growth</td>
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<td>The Theory of General Equilibrium</td>
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<td>ECON 1870</td>
<td>Game Theory and Applications to Economics</td>
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<tr>
<td>Select one 1000-level course from the &quot;data methods&quot; group: 2</td>
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<tr>
<td>ECON 1301</td>
<td>Economics of Education I</td>
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<td>ECON 1375</td>
<td>Inequality of Opportunity in the US</td>
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<td>ECON 1400</td>
<td>The Economics of Mass Media</td>
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</table>

**Applied Mathematics-Economics** 3
<table>
<thead>
<tr>
<th>ECON 1830</th>
<th>Behavioral Finance</th>
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</table>

**Total Credits: 13**

1. APMA 0330 and APMA 0340 may be substituted with advisor approval, but these are no longer being offered.
2. No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.
3. Or ECON 1110 with permission. For students matriculating at Brown in Fall 2021 or later, note that if ECON 1110 is used, then one additional course from the mathematical-economics group will be required.
4. Note that ECON 1620, ECON 1960, and ECON 1970 (independent study) cannot be used for concentration credit. However, 1620 and 1960 can be used for university credit and up to two 1970s may be used for university credit.
5. Requires written approval of the Director of Undergraduate Studies in Economics. APMA 1910 is not permitted.

### Standard program for the Sc.B. degree (Mathematical Finance track):

**Prerequisites:**
- MATH 0100: Introductory Calculus, Part II
- MATH 0520: Linear Algebra

**Course Requirements: 16 courses:**
- **7 Applied Math and 9 Economics**

#### Applied Mathematics requirements:

<table>
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<th>Prerequisites</th>
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- CSCI 0170: Computer Science: An Integrated Introduction
- CSCI 0190: Accelerated Introduction to Computer Science
- APMA 1650: Statistical Inference I
- APMA 1655: Honors Statistical Inference I

Select two of the following:
- APMA 1160: An Introduction to Numerical Optimization
- APMA 1180: Introduction to Numerical Solution of Differential Equations
- APMA 1210: Operations Research: Deterministic Models
- APMA 1330: Applied Partial Differential Equations II
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- APMA 1660: Statistical Inference II
- APMA 1670: Statistical Analysis of Time Series
- APMA 1680: Nonparametric Statistics
- APMA 1690: Computational Probability and Statistics
- APMA 1710: Information Theory
- APMA 1720: Monte Carlo Simulation with Applications to Finance (preferred)
- APMA 1740: Recent Applications of Probability and Statistics
- APMA 1860: Graphs and Networks

**Economics Requirements:**

- ECON 1130: Intermediate Microeconomics (Mathematical)
- ECON 1210: Intermediate Macroeconomics
- ECON 1630: Mathematical Econometrics I
- Select three 1000-level courses from the "financial economics" group:
  - ECON 1710: Investments I
  - ECON 1720: Corporate Finance
  - ECON 1730: Venture Capital, Private Equity, and Entrepreneurship
  - ECON 1750: Investments II
  - ECON 1760: Financial Institutions
  - ECON 1780: Advanced Topics in Corporate Finance
  - ECON 1830: Behavioral Finance

Select two 1000-level courses from the "mathematical economics" group:
- ECON 1701: Advanced Topics In Econometrics
- ECON 1702: Big Data
- ECON 1703: Machine Learning, Text Analysis, and Economics
- ECON 1704: Mathematics in the Laboratory
- ECON 1705: Theory of General Equilibrium
- ECON 1780: Game Theory and Applications to Economics

Select one 1000-level course from the "data methods" group:
- ECON 1860: Machine Learning, Text Analysis, and Economics
- ECON 1865: The Economics of Social Policy
- ECON 1866: The Economics of Mass Media
- ECON 1867: The Economics of Global Warming
- ECON 1868: The Economics of Education I
- ECON 1870: Behavioral Finance

- ECON 1875: Inequality of Opportunity in the US
- ECON 1890: The Economics of Social Policy
- ECON 1891: Public Economics
- ECON 1892: Economic Development
- ECON 1893: Health, Hunger and the Household in Developing Countries
- ECON 1895: Mathematical Econometrics II
- ECON 1896: Big Data
- ECON 1897: Advanced Topics in Econometrics

- ECON 1170: Welfare Economics and Social Choice
- ECON 1225: Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
- ECON 1255: Unemployment: Models and Policies
- ECON 1470: Bargaining Theory and Applications
- ECON 1490: Designing Internet Marketplaces
- ECON 1545: Topics in Macroeconomics, Development and International Economics
- ECON 1640: Mathematical Econometrics II
- ECON 1660: Big Data
- ECON 1670: Advanced Topics in Econometrics
- ECON 1680: Machine Learning, Text Analysis, and Economics
- ECON 1685: The Economics of Social Policy
- ECON 1686: The Economics of Education I
- ECON 1688: Economics in the Laboratory
- ECON 1690: Theory of Behavioral Economics
- ECON 1695: Theory of Economic Growth
- ECON 1696: The Theory of General Equilibrium
- ECON 1697: Game Theory and Applications to Economics
- ECON 1701: Advanced Topics In Econometrics
- ECON 1702: Big Data
- ECON 1703: Machine Learning, Text Analysis, and Economics
- ECON 1704: Mathematics in the Laboratory
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- ECON 1895: Mathematical Econometrics II
- ECON 1896: Big Data
- ECON 1897: Advanced Topics in Econometrics
ECON 1680  Machine Learning, Text Analysis, and Economics
ECON 1825  Behavioral Economics and Public Policy
ECON 1830  Behavioral Finance

Total Credits  16

1  APMA 0330 and APMA 0340 may be substituted with advisor approval, but these are no longer being offered.
2  No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.
3  Or ECON 1110 with permission. For students matriculating at Brown in Fall 2021 or later, note that if ECON 1110 is used, then one additional course from the mathematical-economics group will be required.
4  Note that ECON 1620, ECON 1960, and ECON 1970 (independent study) cannot be used for concentration credit. However, 1620 and 1960 can be used for university credit and up to two 1970s may be used for university credit.
5  Requires written approval of the Director of Undergraduate Studies in Economics. APMA 1910 is not permitted.

Honors

Applied Math-Economics concentrators who wish to pursue honors must find a primary faculty thesis advisor in either Economics or Applied Math. They will be held to the Honors requirements of their advisor’s department. Joint concentrators in Applied Mathematics-Economics with an Economics thesis advisor should follow the requirements published here (https://economics.brown.edu/academics/undergraduate/honors-and-capstones/thesis/), while concentrators with an Applied Math thesis advisor should follow the requirements published here (https://www.brown.edu/academics/applied-mathematics/undergraduate-program/honors/).

Professional Track

The requirements for the professional track include all those of the standard track, 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.

• 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.