# 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 economics. The second is the mathematical finance track, which is intended to prepare students for graduate study in finance, or 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) - through the class of 2015:

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

### Course Requirements:

#### Applied Math Requirements:

(a) $^1$
- APMA 0350 & APMA 0360 Applied Ordinary Differential Equations and Applied Partial Differential Equations $^2$ 2
- APMA 0160 Introduction to Scientific Computing 1
- CSCI 0040 Introduction to Scientific Computing and Problem Solving
- CSCI 0150 Introduction to Object-Oriented Programming and Computer Science
- CSCI 0170 Computer Science: An Integrated Introduction 1
- APMA 1200 Operations Research: Probabilistic Models 1
- APMA 1210 Operations Research: Deterministic Models
- APMA 1650 Statistical Inference I $^1$ 1

(b) $^2$
- APMA 1200 Operations Research: Probabilistic Models
- APMA 1210 Operations Research: Deterministic Models
- APMA 1660 Statistical Inference II
- APMA 1670 Statistical Analysis of Time Series
- APMA 1680 Nonparametric Statistics
- APMA 1690 Computational Probability and Statistics
- APMA 1700 The Mathematics of Insurance
- APMA 1740 Recent Applications of Probability and Statistics
- MATH 1010 Analysis: Functions of One Variable 1

### Economics Requirements:
- ECON 1130 Intermediate Microeconomics (Mathematical) $^3$ 1
- ECON 1210 Intermediate Macroeconomics
- ECON 1630 Econometrics I

Two 1000-level courses from the "mathematical-economics" group, below: 2
- ECON 1170 Welfare Economics and Social Choice Theory
- ECON 1225 Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
- ECON 1465 Market Design: Theory and Applications
- ECON 1470 Bargaining Theory and Applications
- ECON 1640 Econometrics II
- ECON 1650 Financial Econometrics
- ECON 1750 Investments II
- ECON 1759 Data, Statistics, Finance
- ECON 1810 Economics and Psychology
- ECON 1820 Behavioral Economics
- ECON 1850 Theory of Economic Growth
- ECON 1860 The Theory of General Equilibrium
- ECON 1870 Game Theory and Applications to Economics

One additional 1000-level economics course. 1

Total Credits: 12

$^1$ No course may be used to simultaneously satisfy (a) and (b).

$^2$ APMA 0330 and APMA 0340 may be substituted with advisor approval.

$^3$ Or ECON 1110 with permission.

## Standard program for the Sc.B. degree (Advanced Economics track) - through the class of 2015:

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

### Course requirements:

#### Applied Mathematics requirements:

(a) $^1$
- APMA 0350 & APMA 0360 Applied Ordinary Differential Equations and Applied Partial Differential Equations $^2$ 2
- APMA 0160 Introduction to Scientific Computing 1
- CSCI 0040 Introduction to Scientific Computing and Problem Solving
- CSCI 0150 Introduction to Object-Oriented Programming and Computer Science
- CSCI 0170 Computer Science: An Integrated Introduction 1
- APMA 1200 Operations Research: Probabilistic Models 1
- APMA 1210 Operations Research: Deterministic Models
- APMA 1650 Statistical Inference I $^1$ 1

(b) $^2$
- APMA 1200 Operations Research: Probabilistic Models
- APMA 1210 Operations Research: Deterministic Models
- APMA 1660 Statistical Inference II
- APMA 1670 Statistical Analysis of Time Series
- APMA 1680 Nonparametric Statistics
- APMA 1690 Computational Probability and Statistics
- APMA 1700 The Mathematics of Insurance
- APMA 1740 Recent Applications of Probability and Statistics
- MATH 1010 Analysis: Functions of One Variable 1

#### Economics requirements:
- ECON 1130 Intermediate Microeconomics (Mathematical) $^3$ 1
- ECON 1210 Intermediate Macroeconomics 1
- ECON 1630 Econometrics I 1

Three 1000-level courses from the "mathematical-economics" group, below: 3
- ECON 1170 Welfare Economics and Social Choice Theory
- ECON 1225 Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
- ECON 1465 Market Design: Theory and Applications
- ECON 1470 Bargaining Theory and Applications
ECON 1640     Econometrics II
ECON 1650     Financial Econometrics
ECON 1750     Investments II
ECON 1759     Data, Statistics, Finance
ECON 1810     Economics and Psychology
ECON 1820     Behavioral Economics
ECON 1850     Theory of Economic Growth
ECON 1860     The Theory of General Equilibrium
ECON 1870     Game Theory and Applications to Economics
Two additional 1000-level economics courses.  2
Total Credits  15

1 No course may be used to simultaneously satisfy (a) and (b).
2 APMA 0330 and APMA 0340 may be substituted with advisor approval.
3 Or ECON 1110 with permission.

Standard program for the A.B. degree (Mathematical Finance track) - through the class of 2015:

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

Requirements:  
Applied Mathematics requirements:  
(a)  
APMA 0350     Applied Ordinary Differential Equations  
& APMA 0360     and Applied Partial Differential Equations I  2
Select one of the following:  1
APMA 0160     Introduction to Scientific Computing
CSCI 0040     Introduction to Scientific Computing and Problem Solving
CSCI 0150     Introduction to Object-Oriented Programming and Computer Science
CSCI 0170     Computer Science: An Integrated Introduction
APMA 1200     Operations Research: Probabilistic Models  1
APMA 1650     Statistical Inference I  1
(b)  
Select one of the following:  1
APMA 1180     Introduction to Numerical Solution of Differential Equations
APMA 1330     Applied Partial Differential Equations II
APMA 1660     Statistical Inference II
APMA 1670     Statistical Analysis of Time Series
APMA 1680     Nonparametric Statistics
APMA 1690     Computational Probability and Statistics
APMA 1700     The Mathematics of Insurance
APMA 1720     Monte Carlo Simulation with Applications to Finance (most preferred in this list)
APMA 1740     Recent Applications of Probability and Statistics
MATH 1010     Analysis: Functions of One Variable

Economics Requirements:  
ECON 1130     Intermediate Microeconomics (Mathematical)  2
ECON 1210     Intermediate Macroeconomics  1
ECON 1630     Econometrics I  1
Select two 1000-level courses from the "financial economics" group:  3  2
ECON 1650     Financial Econometrics
ECON 1710     Investments I
ECON 1720     Corporate Finance
ECON 1750     Investments II
ECON 1759     Data, Statistics, Finance
ECON 1760     Financial Institutions
ECON 1765     Finance, Regulation, and the Economy: Research
ECON 1770     Fixed Income Securities
ECON 1780     Corporate Strategy
ECON 1790     Corporate Governance and Management

Select one 1000-level course from the "mathematical economics" group:  1
ECON 1170     Welfare Economics and Social Choice Theory
ECON 1225     Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
ECON 1465     Market Design: Theory and Applications
ECON 1470     Bargaining Theory and Applications
ECON 1640     Econometrics II
ECON 1650     Financial Econometrics
ECON 1750     Investments II
ECON 1759     Data, Statistics, Finance
ECON 1810     Economics and Psychology
ECON 1820     Behavioral Economics
ECON 1850     Theory of Economic Growth
ECON 1860     The Theory of General Equilibrium
ECON 1870     Game Theory and Applications to Economics

Total Credits  12

1 APMA 0330 and APMA 0340 may be substituted with advisor approval.
2 Or ECON 1110 with permission.
3 No course may be used to simultaneously satisfy the "financial economics" and the "mathematical economics" requirements.

Standard program for the Sc.B. degree (Mathematical Finance track) - through the class of 2015:

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

Course requirements:  
Applied Mathematics requirements:  
(a)  
APMA 0350     Applied Ordinary Differential Equations  
& APMA 0360     and Applied Partial Differential Equations I  2
Select one of the following:  1
APMA 0160     Introduction to Scientific Computing
CSCI 0040     Introduction to Scientific Computing and Problem Solving
CSCI 0150     Introduction to Object-Oriented Programming and Computer Science
CSCI 0170     Computer Science: An Integrated Introduction
APMA 1200     Operations Research: Probabilistic Models  1
APMA 1650     Statistical Inference I  1
(b)  
Select two of the following:  2
APMA 1180     Introduction to Numerical Solution of Differential Equations
APMA 1330     Applied Partial Differential Equations II
APMA 1660     Statistical Inference II
APMA 1670     Statistical Analysis of Time Series
APMA 1680     Nonparametric Statistics
APMA 1690     Computational Probability and Statistics
APMA 1700     The Mathematics of Insurance

APMA 1180     Introduction to Numerical Solution of Differential Equations
APMA 1330     Applied Partial Differential Equations II
APMA 1660     Statistical Inference II
APMA 1670     Statistical Analysis of Time Series
APMA 1680     Nonparametric Statistics
APMA 1690     Computational Probability and Statistics
APMA 1700     The Mathematics of Insurance
**Select one of the following:**

| APMA 120 | Operations Research: Deterministic Models |
| APMA 1210 | Operations Research: Probabilistic Models |
| APMA 1650 | Statistical Inference I |

**Economics Requirements:**

| ECON 1130 | Intermediate Microeconomics (Mathematical) |
| ECON 1210 | Intermediate Macroeconomics |
| ECON 1630 | Econometrics I |

Select three 1000-level courses from the "financial economics" group: 3

| ECON 1650 | Financial Econometrics |
| ECON 1710 | Investments I |
| ECON 1720 | Corporate Finance |
| ECON 1750 | Investments II |
| ECON 1759 | Data, Statistics, Finance |
| ECON 1760 | Financial Institutions |
| ECON 1765 | Finance, Regulation, and the Economy: Research |
| ECON 1770 | Fixed Income Securities |
| ECON 1780 | Corporate Strategy |
| ECON 1790 | Corporate Governance and Management |

Select two 1000-level courses from the "mathematical economics" group: 2

| ECON 1170 | Welfare Economics and Social Choice Theory |
| ECON 1225 | Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies |
| ECON 1465 | Market Design: Theory and Applications |
| ECON 1470 | Bargaining Theory and Applications |
| ECON 1640 | Econometrics II |
| ECON 1650 | Financial Econometrics |
| ECON 1750 | Investments II |
| ECON 1759 | Data, Statistics, Finance |
| ECON 1810 | Economics and Psychology |
| ECON 1820 | Behavioral Economics |
| ECON 1850 | Theory of Economic Growth |
| ECON 1860 | The Theory of General Equilibrium |
| ECON 1870 | Game Theory and Applications to Economics |

Total Credits 15

1 APMA 0330 and APMA 0340 may be substituted with advisor approval.

2 Or ECON 1110 with permission.

3 No course may be used to simultaneously satisfy the "financial economics" and the "mathematical economics" requirements.

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

(Advanced Economics track) - class of 2016 and beyond:

**Prerequisites:**

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

**Course Requirements:**

**Applied Mathematics Requirements**

(a) 1

| APMA 0350 | Applied Ordinary Differential Equations |
| & APMA 0360 | Applied Partial Differential Equations |

Select one of the following: 1

| APMA 0160 | Introduction to Scientific Computing (preferred) |
| CSCI 0040 | Introduction to Scientific Computing and Problem Solving (preferred) |

| CSCI 0150 | Introduction to Object-Oriented Programming and Computer Science |
| CSCI 0170 | Computer Science: An Integrated Introduction |

Select one of the following: 1

| APMA 120 | Operations Research: Deterministic Models |
| APMA 1210 | Operations Research: Probabilistic Models |
| APMA 1650 | Statistical Inference I |

(b) 1

Select one of the following: 1

| APMA 120 | Operations Research: Deterministic Models |
| APMA 1210 | Operations Research: Probabilistic Models |
| APMA 1660 | Statistical Inference II |
| APMA 1670 | Statistical Analysis of Time Series |
| APMA 1680 | Nonparametric Statistics |
| APMA 1690 | Computational Probability and Statistics |
| APMA 1700 | The Mathematics of Insurance |
| APMA 1740 | Recent Applications of Probability and Statistics |
| MATH 1010 | Analysis: Functions of One Variable |

**Economics Requirements:**

| ECON 1130 | Intermediate Microeconomics (Mathematical) |
| ECON 1210 | Intermediate Macroeconomics |
| ECON 1630 | Econometrics I |

Two 1000-level courses from the "mathematical-economics" group: 2

| ECON 1170 | Welfare Economics and Social Choice Theory |
| ECON 1225 | Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies |
| ECON 1465 | Market Design: Theory and Applications |
| ECON 1470 | Bargaining Theory and Applications |
| ECON 1640 | Econometrics II |
| ECON 1650 | Financial Econometrics |
| ECON 1750 | Investments II |
| ECON 1759 | Data, Statistics, Finance |
| ECON 1810 | Economics and Psychology |
| ECON 1820 | Behavioral Economics |
| ECON 1850 | Theory of Economic Growth |
| ECON 1860 | The Theory of General Equilibrium |
| ECON 1870 | Game Theory and Applications to Economics |

One 1000-level course from the "data methods" group: 2

| ECON 1305 | Economics of Education: Research |
| ECON 1310 | Labor Economics |
| ECON 1360 | Health Economics |
| ECON 1410 | Urban Economics |
| ECON 1510 | Economic Development |
| ECON 1520 | The Economic Analysis of Institutions |
| ECON 1530 | Health, Hunger and the Household in Developing Countries |
| ECON 1640 | Econometrics II |
| ECON 1650 | Financial Econometrics |
| ECON 1759 | Data, Statistics, Finance |
| ECON 1765 | Finance, Regulation, and the Economy: Research |

One additional 1000-level economics course 1

Total Credits 13

1 No course may be used to simultaneously satisfy (a) and (b).

2 APMA 0330 and APMA 0340 may be substituted with advisor approval.

3 Or ECON 1110 with permission.

4 No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.
Standard program for the Sc.B. degree
(Advanced Economics track) - class of 2016 and beyond

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

Course Requirements:
Applied Mathematics Requirements

(a) 1
- Select one of the following:
  - APMA 0160  Introduction to Scientific Computing (preferred)
  - CSCI 0040  Introduction to Scientific Computing and Problem Solving (preferred)
  - CSCI 0150  Introduction to Object-Oriented Programming and Computer Science
  - CSCI 0170  Computer Science: An Integrated Introduction

(b) 1
- Select two of the following:
  - APMA 1200  Operations Research: Probabilistic Models
  - APMA 1210  Operations Research: Deterministic Models
  - APMA 1650  Statistical Inference I
- Select one of the following:
  - APMA 1200  Operations Research: Probabilistic Models
  - APMA 1210  Operations Research: Deterministic Models
  - APMA 1660  Statistical Inference II
  - APMA 1670  Statistical Analysis of Time Series
  - APMA 1680  Nonparametric Statistics
  - APMA 1690  Computational Probability and Statistics
  - APMA 1700  The Mathematics of Insurance
  - APMA 1740  Recent Applications of Probability and Statistics
  - MATH 1010  Analysis: Functions of One Variable

Economics Requirements:
- ECON 1130  Intermediate Microeconomics (Mathematical) 3
- ECON 1210  Intermediate Macroeconomics
- ECON 1630  Econometrics I
- Three 1000-level courses from the "mathematical-economics" group: 4
  - ECON 1170  Welfare Economics and Social Choice Theory
  - ECON 1225  Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
  - ECON 1465  Market Design: Theory and Applications
  - ECON 1470  Bargaining Theory and Applications
  - ECON 1640  Econometrics II
  - ECON 1650  Financial Econometrics
  - ECON 1750  Investments II
  - ECON 1759  Data, Statistics, Finance
  - ECON 1810  Economics and Psychology
  - ECON 1820  Behavioral Economics
  - ECON 1850  Theory of Economic Growth
  - ECON 1860  The Theory of General Equilibrium
  - ECON 1870  Game Theory and Applications to Economics
- One 1000-level course from the "data methods" group: 4
  - ECON 1305  Economics of Education: Research
  - ECON 1310  Labor Economics
  - ECON 1360  Health Economics
  - ECON 1410  Urban Economics
  - ECON 1510  Economic Development

Two additional 1000-level economics courses
- 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.
3 No course may be used to simultaneously satisfy (a) and (b).
4 No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.

Standard program for the A.B. degree
(Mathematical Finance track) - class of 2016 and beyond

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

Course Requirements:
Applied Mathematics Requirements

(a) 1
- Select one of the following:
  - APMA 0160  Introduction to Scientific Computing (preferred)
  - CSCI 0040  Introduction to Scientific Computing and Problem Solving (preferred)
  - CSCI 0150  Introduction to Object-Oriented Programming and Computer Science
  - CSCI 0170  Computer Science: An Integrated Introduction

(b) 1
- Select two of the following:
  - APMA 1200  Operations Research: Probabilistic Models
  - APMA 1210  Operations Research: Deterministic Models
  - APMA 1650  Statistical Inference I
- Select one of the following:
  - APMA 1200  Operations Research: Probabilistic Models
  - APMA 1210  Operations Research: Deterministic Models
  - APMA 1660  Statistical Inference II
  - APMA 1670  Statistical Analysis of Time Series
  - APMA 1680  Nonparametric Statistics
  - APMA 1690  Computational Probability and Statistics
  - APMA 1700  The Mathematics of Insurance
  - APMA 1740  Recent Applications of Probability and Statistics
  - MATH 1010  Analysis: Functions of One Variable

Economics Requirements:
- ECON 1130  Intermediate Microeconomics (Mathematical) 3
- ECON 1210  Intermediate Macroeconomics
- ECON 1630  Econometrics I
- Three 1000-level courses from the "mathematical-economics" group: 4
  - ECON 1170  Welfare Economics and Social Choice Theory
  - ECON 1225  Advanced Macroeconomics: Monetary, Fiscal, and Stabilization Policies
  - ECON 1465  Market Design: Theory and Applications
  - ECON 1470  Bargaining Theory and Applications
  - ECON 1640  Econometrics II
  - ECON 1650  Financial Econometrics
  - ECON 1750  Investments II
  - ECON 1759  Data, Statistics, Finance
  - ECON 1810  Economics and Psychology
  - ECON 1820  Behavioral Economics
  - ECON 1850  Theory of Economic Growth
  - ECON 1860  The Theory of General Equilibrium
  - ECON 1870  Game Theory and Applications to Economics
- One 1000-level course from the "data methods" group: 4
  - ECON 1305  Economics of Education: Research
  - ECON 1310  Labor Economics
  - ECON 1360  Health Economics
  - ECON 1410  Urban Economics
  - ECON 1510  Economic Development

- ECON 1520  The Economic Analysis of Institutions
- ECON 1530  Health, Hunger and the Household in Developing Countries
- ECON 1640  Econometrics II
- ECON 1650  Financial Econometrics
- ECON 1759  Data, Statistics, Finance
- ECON 1765  Finance, Regulation, and the Economy: Research

Two additional 1000-level economics courses
- 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.
3 Or ECON 1110 with permission.
4 No course may be used to simultaneously satisfy the "mathematical economics" and the "data methods" requirements.
Select one 1000-level course from the "mathematical economics" group:

- ECON 1710 Intermediate Microeconomics (Mathematical)
- ECON 1130 Intermediate Microeconomics
- ECON 1630 Econometrics I
Select three 1000-level courses from the "financial economics" group:

- ECON 1650 Financial Econometrics
- ECON 1710 Investments I
- ECON 1720 Corporate Finance
- ECON 1750 Investments II
- ECON 1759 Data, Statistics, Finance
- ECON 1760 Financial Institutions
- ECON 1765 Finance, Regulation, and the Economy: Research
- ECON 1770 Fixed Income Securities
- ECON 1780 Corporate Strategy
- ECON 1790 Corporate Governance and Management
ECON 1640 Econometrics II
ECON 1650 Financial Econometrics
ECON 1759 Data, Statistics, Finance
ECON 1765 Finance, Regulation, and the Economy: Research

Total Credits 16

1 APMA 0330 and APMA 0340 may be substituted with advisor approval.
2 No course may be used to simultaneously satisfy the "financial economics," the "mathematical economics," or the "data methods" requirements.
3 Or ECON 1110 with permission.

Honors and Capstone Requirement
Admission to candidacy for honors in the concentration is granted on the following basis: 3.7 GPA for Economics courses, and a 3.5 GPA overall.
To graduate with honors, a student must write an honors thesis in the senior year following the procedures specified by the concentration (see Economics Department website). Beginning with the class of 2016, students not writing an honors thesis must complete an alternative senior capstone project and obtain the approval of a faculty sponsor.

Professional Track
The requirements for the professional track include all those of the standard track, as well as the following:
Students must complete two two-to-four month full-time professional experiences, doing work that is related to their concentration programs. Such work is normally done within an industrial organization, but may also be at a university under the supervision of a faculty member.
On completion of each professional experience, the student must write and upload to ASK a reflective essay about the experience addressing the following prompts, 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.
Font Notice

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Helvetica was used instead of Arial.

The editor may contact Leepfrog for a draft with the correct fonts in place.