Mathematics and economics are complementary disciplines. Most branches of modern economics use mathematics and statistics extensively, and some important areas of mathematical research have been motivated by economic problems. Economists and mathematicians have made important contributions to one another’s disciplines. Economist Kenneth Arrow, for example, did path-breaking work in the field of mathematical optimization, and in 1994, Mathematician John Nash was awarded the Nobel Prize in economics for work he did in game theory that has become central to contemporary economic theory. Haverford’s Area of Concentration in Mathematical Economics enables students in both disciplines not only to gain proficiency in the other, but also to appreciate the ways in which they are related.

Economics students with a variety of backgrounds and career interests can benefit from completing the concentration. The mathematics courses the concentration requires are extremely valuable for students interested in pursuing graduate study in economics. A strong mathematical background is also an asset for students going on to business school or graduate programs in public policy. Many economics-related jobs in government, business, and finance require strong quantitative skills, and the concentration prepares students interested in seeking such positions.

The concentration can also benefit mathematics majors. Many students find mathematics more exciting and meaningful when they see it applied to a discipline they find interesting and concrete. Almost every undergraduate mathematics course covers topics useful in economic applications: optimization techniques in multivariable calculus, quadratic forms in linear algebra, and fixed point theorems in topology. In intermediate and advanced courses in economics, mathematics majors can see how these tools and methods are applied in another discipline.

**LEARNING GOALS**

Students in Area of Concentration in Mathematical Economics will:
- engage in theoretical and empirical analysis of economic problems using formal theoretical and empirical methods.
- develop tools and techniques, including the use of formal arguments, numerical computations, and empirical analysis, to understand the logic, validity and robustness of various economic ideas.
- recognize that most branches of modern economics use mathematics and statistics extensively, and that some important areas of mathematical research have been motivated by economic problems.
- understand the complementarities between the two disciplines to gain proficiency in each, and appreciate the ways in which they are related.

**CONCENTRATION REQUIREMENTS**

Students enrolling in the Area of Concentration in Mathematical Economics must major in either mathematics or economics.

**For students majoring in mathematics, the Concentration requires six courses:**
- Three required mathematics courses:
  - ECON 105 or 106 (Introduction to Economics). (Students who, with permission of the Economics Department, place out of ECON 105/106, must replace ECON 105/106 with an economics elective at the 200 level or above.)
  - ECON 204 (Economic Statistics with Calculus), or an applied statistics course offered by the economics or mathematics department at an equivalent or higher level.
  - ECON 300 (Intermediate Microeconomics).
- One additional elective in economics at the 200 level or above.
- Two mathematics electives on topics with significant relevance or applicability to economics. (Students may count these courses toward fulfillment of the mathematics major as well as the Area of Concentration in Mathematical Economics.)

**For students majoring in economics, the Concentration requires six courses:**
- Three required economics courses:
  - MATH 121 (Multivariable Calculus) or MATH 216 (Advanced Calculus)
  - MATH 215 (Linear Algebra)
  - MATH 317 (Analysis I)
MATHEMATICAL ECONOMICS

- One additional elective in mathematics at the 200 level or above.
- Two economics electives involving significant applications of mathematical methods.
  (Students may count these courses toward fulfillment of the economics major as well as the Area of Concentration in Mathematical Economics.)

Students must consult with the concentration coordinator, or the economics or mathematics department representative (as appropriate), about selecting the electives for the concentration (as explained in the requirements above).

Additional Remarks
The Area of Concentration in Mathematical Economics differs from the minors in mathematics and economics in a specific way: it focuses on the complementarities between the two disciplines; the minors in mathematics and economics are designed to provide a basic foundation in each discipline, but not necessarily an inter-disciplinary orientation.

A student majoring in economics may choose to pursue either the Area of Concentration in Mathematical Economics or a minor in mathematics, but not both. A student majoring in mathematics may choose to pursue either the Area of Concentration in Mathematical Economics or a minor in economics, but not both. A student double-majoring in economics and mathematics may not enroll in the Area of Concentration in Mathematical Economics.

RELATED COURSES
Below is a list of courses that have fulfilled the mathematics and economics elective requirements in previous years. This list is neither definitive nor exhaustive. It is subject to change. Students are strongly encouraged to consult with the concentration coordinator or department representative when choosing electives.

Mathematics Electives
- MATH 210 Linear Optimization and Game Theory; cross-listed as ECON 210
- MATH 218 Probability
- MATH 222 Scientific Computing
- MATH 231 Discrete Mathematics
- MATH 328 Mathematical Statistics
- MATH 340 Analysis of Algorithms
- MATH 360 Mathematical Economics; cross-listed as ECON 360
- MATH 396 Advanced Topics in Probability and Statistics.

Economics Electives
- ECON 210 Linear Optimization and Game Theory; cross-listed as MATH 210
- ECON 237 Game Theory in Economics
- ECON 355 Advanced Microeconomics: Uncertainty
- ECON 360 Mathematical Economics; cross-listed as MATH 360
- ECON 374 Jr. Research Seminar: Topics in Industrial Organization
- ECON 377 Junior Research Seminar: Political Economy

FACULTY/COORDINATORS
Richard Ball
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Lynne Butler
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