

# Economics

## The School of Social Sciences

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*Degrees Offered:* B.A., M.A., Ph.D.

Undergraduates may major in either economics or mathematical economic analysis. The latter is recommended for students who intend to continue on to graduate work in economics or pursue a business or governmental job in which analytical and quantitative skills are required.

The eight major fields available for graduate study are econometrics, economic development, economic theory, industrial organization and regulation, international trade and finance, labor, macroeconomics and/or monetary theory, and public finance.

### Degree Requirements for B.A. in Economics or Mathematical Economic Analysis

**Economics Major.** All economics majors must complete a minimum of 10 courses with a grade point average of at least 2.00.

(1) These courses include 9 economics courses and 1 course in quantitative analysis as specified in (4) below. Major requirements are not reduced for multiple majors, although some courses can satisfy the requirements for more than one major. (Please note that students may not pursue a double major in economics and mathematical economic analysis.)

(2) The following courses are required for all economics majors:

- ECON 211 *Principles of Economics I*
- ECON 212 *Principles of Economics II*
- ECON 370 *Microeconomic Theory*
- And either ECON 355 *Financial Markets and Institutions*, ECON 375 *Macroeconomic Theory*, or ECON 455 *Money and Financial Markets*.

We suggest that economics majors take ECON 211 and 212 in the freshman year and take ECON 370 in the first semester of their sophomore year, leaving the junior and senior years for advanced electives. This plan is optional, but please note that failure to take prerequisite courses in earlier years may cause scheduling problems in later years.

(3) Given that item (2) has been satisfied, at least 3 of the remaining 5 required economics courses must be selected from the following courses in applied economics.

ECON 301 <i>History of Economic Analysis</i>	ECON 448 <i>Corporation Finance</i>
ECON 355 <i>Financial Markets and Institutions</i>	ECON 450 <i>World Economic and Social Development</i>
ECON 375 <i>Macroeconomic Theory</i>	ECON 451 <i>The Political Economy of Latin America</i>
ECON 415 <i>Labor Economics</i>	ECON 452 <i>Principles of Islamic Economics</i>
ECON 416 <i>Economic History of the U.S., 1700–1945</i>	ECON 455 <i>Money and Financial Markets</i>
ECON 417 <i>Comparative History of Industrialization</i>	ECON 461 <i>Urban Economics</i>
ECON 420 <i>International Economics</i>	ECON 472 <i>Introduction to Game Theory</i>
ECON 421 <i>International Finance</i>	ECON 480 <i>Environmental and Energy Economics</i>
ECON 430 <i>Comparative Economic Systems</i>	ECON 482 <i>Distributive Justice—A Microeconomic Approach</i>
ECON 435 <i>Industrial Organization</i>	ECON 483 <i>Public Finance—Tax Policy</i>
ECON 436 <i>Government Regulation of Business</i>	ECON 484 <i>Public Expenditure Theory and Social Insurance</i>
ECON 437 <i>Economics of Information, Common Property Resources, and Public Goods</i>	ECON 485 <i>Contemporary Economic Issues</i>
ECON 438 <i>Economics of Law I</i>	ECON 486 <i>Contemporary Economic Issues</i>
ECON 439 <i>Economics of Law II</i>	ECON 495 <i>Senior Seminar</i>
ECON 440 <i>Financial Theory</i>	
ECON 445 <i>Managerial Economics</i>	

Please note that if you count ECON 355, 375, or 455 as 1 of the required courses in item (2), you may not also count that course as 1 of the 3 courses satisfying item (3).

(4) The quantitative methods course may be selected from the following.

ECON 380 <i>Applied Economics</i>	CAAM 322 <i>Introduction to Real Analysis II</i>
ECON 382 <i>Probability and Statistics</i>	CAAM 335 <i>Matrix Analysis</i>
ECON 400 <i>Econometrics</i>	CAAM 336 <i>Differential Equations in Science and Engineering</i>
ECON 471 <i>Linear Programming</i>	CAAM 353 <i>Computational Numerical Analysis</i>
ECON 475 <i>Integer and Combinatorial Optimization</i>	CAAM 376 <i>Introduction to Management Science</i>
ECON 477 <i>Mathematical Structure of Economic Theory</i>	CAAM 378 <i>Introduction to Operations Research</i>
ECON 478 <i>Economic Applications of Mathematical Programming</i>	CAAM 400 <i>Case Studies in Applied Mathematics</i>
ECON 479 <i>Operations Research—Elementary Discrete Optimization</i>	CAAM 435 <i>Ordinary Differential Equations</i>
ACCO 305 <i>Introduction to Accounting</i>	CAAM 436 <i>Partial Differential Equations I</i>
CAAM 210 <i>Introduction to Engineering Computation</i>	CAAM 437 <i>Partial Differential Equations II</i>
CAAM 211 <i>Introduction to Engineering Computation</i>	
CAAM 321 <i>Introduction to Real Analysis</i>	

CAAM 451 <i>Numerical Linear Algebra</i>	COMP 440 <i>Artificial Intelligence</i>
CAAM 452 <i>Computational Methods for Differential Equations</i>	COMP 480 <i>Concrete Mathematics</i>
CAAM 453 <i>Numerical Analysis and Ordinary Differential Equations</i>	COMP 482 <i>Design and Analysis of Algorithms</i>
CAAM 454 <i>Optimization Problems in Computational Engineering and Science</i>	STAT 305 <i>Introduction to Statistics for Biosciences</i>
CAAM 460 <i>Optimization Theory</i>	STAT 310 <i>Probability and Statistics</i>
CAAM 471 <i>Linear Programming</i>	STAT 331 <i>Applied Probability</i>
CAAM 474 <i>Theory of Linear Inequalities</i>	STAT 381 <i>Introduction to Applied Probability</i>
CAAM 475 <i>Integer and Combinatorial Optimization</i>	STAT 400 <i>Econometrics</i>
CAAM 483 <i>Markov and Martingale Sequences—Renewal Processes</i>	STAT 410 <i>Introduction to Statistical Computing and Linear Models</i>
COMP 212 <i>Intermediate Programming</i>	STAT 421 <i>Introduction to Time Series Analysis</i>
COMP 312 <i>Program Construction</i>	STAT 431 <i>Mathematical Statistics</i>
COMP 314 <i>Applied Algorithms and Data Structures</i>	STAT 450 <i>Practicum in Statistical Modeling</i>
	STAT 486 <i>Market Models</i>

or an equivalent or higher-level course approved in advance by the chairman of the undergraduate committee.

(5) We strongly recommend that students take two semesters of calculus (MATH 101/102 or MATH 111/112) and a course in probability and statistics (ECON 382/STAT 310). Failure to take these courses will limit the range of electives available to the student.

(6) No more than 3 of the 9 economics courses may be transferred from other schools. Additional transfer credits in economics may count toward meeting university graduation requirements but not toward fulfillment of the departmental major requirements. The required course in quantitative analysis may also be transferred. AP credits do not count as transfer credits. In order to transfer either ECON 211 or ECON 212, the student must pass a qualifying examination. Students wishing to take either the ECON 211 or ECON 212 qualifying examination must apply to the economics department office in Baker Hall 266B. For additional information on transfer credits, consult “Procedures for Transfer Credit,” available in the economics department office.

(7) Students may graduate with “Honors in Economics” by achieving a B+ (3.33) average in all economics courses and doing two semesters of independent research (for details, consult “Economics 403/404—Senior Independent Research,” available in the Economics Department Office).

(8) For additional course information, consult “Economics Course Descriptions,” compiled by the Rice chapter of the Omicron Delta Epsilon National Economics Honor Society.

(9) Please note that it is primarily the responsibility of the student to satisfy all degree requirements, including the “University Credit Requirements” and “University Distribution Requirements” specified in the General Announcements. Consult with the appropriate departmental adviser, who must sign all registration forms for each major.

(10) Students who are considering either graduate work in economics or a business or governmental job in which analytical and quantitative skills are required should seriously consider obtaining the alternative major in mathematical economic analysis.

**Mathematical Economic Analysis Major.** Students majoring in mathematical economic analysis must take at least 16 courses.

(1) The major in mathematical economic analysis is designed for students who are interested in graduate work in economics or a business or governmental job in which analytical and quantitative skills are required.

(2) Students must choose between the 2 majors offered by the economics department; that is, students may not double major in economics and mathematical economic analysis. Major requirements are not reduced for students with multiple majors.

(3) A minimum of 16 courses (\*) in 6 areas is required. These courses must include:

**(a) 5 courses in Economic Principles:**

ECON 211 *Principles of Economics I*  
ECON 212 *Principles of Economics II*  
ECON 370 *Microeconomic Theory*

ECON 477 *Mathematical Structure of Economic Theory*  
ECON 375 *Macroeconomic Theory*

**(b) 3 courses in Applied Economics, selected from:**

ECON 301 *History of Economic Analysis*  
ECON 355 *Financial Markets and Institutions*  
ECON 380 *Applied Economics*  
ECON 415 *Labor Economics*  
ECON 416 *Economic History of the U.S., 1700-1945*  
ECON 417 *Comparative History of Industrialization*  
ECON 420 *International Economics*  
ECON 421 *International Finance*  
ECON 430 *Comparative Economic Systems*  
ECON 435 *Industrial Organization*  
ECON 436 *Government Regulation of Business*  
ECON 437 *Economics of Information, Common Property Resources, and Public Goods*  
ECON 438 *Economics of Law I*  
ECON 439 *Economics of Law II*  
ECON 440 *Financial Theory*

ECON 445 *Managerial Economics*  
ECON 448 *Corporation Finance*  
ECON 450 *World Economic and Social Development*  
ECON 451 *The Political Economy of Latin America*  
ECON 452 *Principles of Islamic Economics*  
ECON 455 *Money and Financial Markets*  
ECON 461 *Urban Economics*  
ECON 472 *Introduction to Game Theory*  
ECON 480 *Environmental and Energy Economics*  
ECON 482 *Distributive Justice—A Microeconomic Approach*  
ECON 483 *Public Finance—Tax Policy*  
ECON 484 *Public Expenditure Theory and Social Insurance*  
ECON 485 *Contemporary Economic Issues*  
ECON 486 *Contemporary Economic Issues*

**(c) 1 additional 400-level course in Applied Economics as listed in (b) or a course in advanced analysis, selected from:**

ECON 471 *Linear Programming*  
ECON 475 *Integer and Combinatorial Optimization*  
ECON 478 *Economic Applications of Mathematical Programming*  
ECON 479 *Operations Research—Elementary Discrete Optimization*  
CAAM 451 *Numerical Linear Algebra*  
CAAM 452 *Computational Methods for Differential Equations*  
CAAM 453 *Numerical Analysis and Ordinary Differential Equations*  
CAAM 454 *Optimization Problems in Computational Engineering and Science*

CAAM 460 *Optimization Theory*  
CAAM 471 *Linear Programming*  
CAAM 474 *Theory of Linear Inequalities*  
CAAM 475 *Integer and Combinatorial Optimization*  
CAAM 483 *Markov and Martingale Sequences—Renewal Processes*  
STAT 421 *Introduction to Time Series Analysis*  
STAT 450 *Practicum in Statistical Modeling*  
STAT 486 *Market Models*

or an equivalent or higher-level course approved in advance by the chair of the undergraduate committee.

**(d) 1 course in Econometrics:** ECON 400 *Econometrics*

**(e) 5 courses in Mathematics and Statistics:**

- MATH 101 *Single Variable Calculus I*
- MATH 102 *Single Variable Calculus II*
- MATH 211 *Ordinary Differential Equations and Linear Algebra*
- MATH 355 *Linear Algebra* or CAAM 335 *Matrix Analysis*
- MATH 212 *Multivariable Calculus* or MATH 221 *Honors Calculus III*
- ECON 382/STAT 310 *Probability and Statistics*  
or STAT 410 *Introduction to Statistical Computing and Linear Models*  
or STAT 431 *Mathematical Statistics*

**(f) 1 Senior Seminar or Senior Research:** ECON 495/496 *Senior Seminar* or  
ECON 403/404 *Senior Independent Research*

(4) No more than 3 of the required economics courses and 2 of the required Mathematics (or computational and applied mathematics or statistics) courses may be transferred from other schools. Additional transfer credits in economics, mathematics, computational and applied mathematics or statistics may count toward meeting university graduation requirements but not toward fulfillment of the departmental major requirements. AP credits do not count as transfer credits. In order to transfer either 211 or 212, the student must pass a qualifying examination. Students wishing to take either the 211 or 212 qualifying examinations must apply to the economics department office in Baker Hall 266B. For additional information on transfer credits, consult “Procedures for Transfer Credit,” available in the economics department office.

(5) Students may graduate with “Honors in Mathematical Economic Analysis” by achieving a B+ (3.33) average in the 16 courses required for the major and any other economics electives taken.

(6) For additional course information, consult “Economics Course Descriptions,” compiled by the Rice chapter of the Omicron Delta Epsilon National Economics Honor Society.

(7) Please note that it is primarily the responsibility of the student to satisfy all degree requirements, including the “University Credit Requirements” and “University Distribution Requirements” specified in the General Announcements. Consult with the appropriate departmental adviser, who must sign all registration forms for each major.

### **Substituting Economics Graduate Courses for Undergraduate Courses.**

Undergraduate majors satisfying the course prerequisites may, subject to the approval of the instructor and of the departmental undergraduate program chair, substitute certain graduate courses for undergraduate courses. Only highly motivated students with excellent aptitudes for economics and a strong background in mathematics should consider making such substitutions. Typically, but not necessarily, such students will be majors in mathematical economic analysis. Permitted substitutions are as follows:

- ECON 501 for ECON 372 (if student has completed ECON 211 or ECON 370 at Rice)
- ECON 502 for ECON 375 (if student has completed ECON 212 at Rice)
- ECON 504 for ECON 382
- ECON 510 for ECON 400
- Furthermore, ECON 505 and ECON 508 also may be taken by undergraduates and may be used toward satisfying MTEC requirements. Specifically, ECON 505 could be used as 1 of the courses in the applied economics category or in the advanced analysis category, while ECON 508 could be used only in the advanced analysis category.

Note that this set of substitutable graduate courses includes 6 of the 7 courses required during the first year of the Ph.D. program at Rice. Accordingly, such advanced course work would be excellent preparation for graduate study in economics or in some related field such as finance. Taking such graduate courses should also open more opportunities for the student who will be seeking employment immediately after graduation.

### **The Five-Year M.A. Program**

Advanced undergraduate students can, subject to the approval of the departmental five-year M.A. adviser, enter our five-year M.A. program. In this program, a student who has taken advantage of the full menu of graduate course substitutions available could, with an additional year of study at Rice, earn an M.A. in economics.

To obtain the M.A. degree, students must satisfy all of the requirements for Ph.D. candidacy. In particular, students must pass general examinations in microeconomic theory and in macroeconomic theory and econometrics, must pass an examination in a specialized field of study in economics, and must complete an original research project (a dissertation prospectus) that could be developed into a Ph.D. dissertation under the supervision of a faculty member. This work could be an extension of a paper written as a senior independent research project (ECON 403/404). In some cases, at the discretion of the independent research adviser, the paper produced in ECON 403/404 may fulfill this requirement. Finally, the first-year graduate requirement to take ECON 507 Mathematical Economics would be waived with the approval of the departmental five-year M.A. adviser.

Note that any student who subsequently decides to enter the economics Ph.D. program at Rice would be given graduate credit for all 500 level economics courses completed while an undergraduate. The completion of the Ph.D. dissertation typically requires at least one additional year of research (but no additional courses) beyond the M.A. degree.

Students who opt for the five-year M.A. degree program will have different backgrounds and interests on entering Rice and will choose to pursue this option at different stages in their academic careers. The following illustrates two (of many) possible paths to satisfying the MTEC major requirements, while at the same time completing all of the requirements for the M.A. degree over a five-year period.

### **Courses: Sample Path One**

The student enters with AP credit for ECON 211/212 and MATH 101/102, and has an early interest in the five-year M.A. program.

#### ***Freshman Year***

ECON 372, 375, and MATH 211/212

#### ***Senior Year***

ECON 403/404 and ECON 508

#### ***Sophomore Year***

ECON 501; 1 course from Applied Economics category; and MATH 355 or CAAM 310

- Fifth year—Complete all remaining graduate courses and pass all remaining examinations required to achieve Ph.D. candidacy.

#### ***Junior Year***

ECON 502, 504, 505, 510, and 1 course from Applied Economics category

(Note that with AP credit for MATH 101/102, but not for ECON 211/212, the student could substitute ECON 211/212 for ECON 372 and ECON 375 in the freshman year.)

## Courses: Sample Path Two

The student has no relevant AP credit and/or decides to enter the five-year M.A. program only near the end of the sophomore year.

### *Freshman Year*

ECON 211/212 and MATH 101/102

### *Sophomore Year*

ECON 372, 375, and 1 course from applied economics category;  
MATH 211/212

### *Junior Year*

ECON 501, 502, 505, 508;  
MATH 355 or CAAM 310

### *Senior Year*

ECON 504, 510, 403/404, and 1 course from applied economics category

### *Fifth Year*

Complete all remaining graduate courses and pass all remaining examinations required to achieve Ph.D. candidacy.

## Degree Requirements for Ph.D. in Economics

**Preparation for Ph.D. Program.** Applicants to the Ph.D. program should have had at least two semesters in calculus and one in linear algebra. Students who have not met these requirements may complete these prerequisites as Class III students (page 79) before being admitted to the graduate program. All applicants are required to take the Graduate Record Exam.

**Requirements.** For general university requirements, see Graduate Degrees (pages 60–65). Candidates for the Ph.D. degree usually spend from two to two and one-half years in full-time course work and at least one year writing the dissertation; four to five years is a reasonable goal for completing the program. For the Ph.D., students must:

- Complete an approved program of at least 14 courses not including ECON 593/594 *Workshop in Economics I* and ECON 595/596 *Workshop in Economics II*
- Complete an approved program of at least 4 sections of ECON 593/594 *Workshop in Economics I* and ECON 595/596 *Workshop in Economics II*
- Perform satisfactorily on written general examinations in economic theory and econometrics
- Demonstrate proficiency in a major field by taking the relevant courses in that field and performing satisfactorily on a written examination
- Complete and defend orally a doctoral dissertation setting forth in publishable form the results of original research

**See ECON (pages 308–314) in the Courses of Instruction section**