

MATHEMATICAL ECONOMICS (MECO)

Faculty

Director: KB Boomer (Mathematics)

Coordinating Committee: Erdogan Bakir (Economics), Kelly A. Bickel (Mathematics), KB Boomer (Mathematics), Vahid Gholampour (Economics), Thomas C. Kinnaman (Economics), Nathan C. Ryan (Mathematics)

Mathematics has traditionally served as the language of the natural sciences, and more recently it has become a useful tool in the social sciences, particularly in economics.

The Bachelor of Science in Mathematical Economics at Bucknell University was developed jointly by the Department of Mathematics and the Department of Economics. It is a coordinated curriculum that incorporates economics, mathematics, and statistics to provide the strong foundations that offer students both the intellectual and the quantitative skills to grapple with questions at the interface of these two disciplines.

Students interested in economics and mathematics could also consider a double major in Economics and Mathematics within the B.A. degree program, or combine a B.A. in one of these disciplines with an academic minor in the other. Students who plan to attend graduate school in economics might consider the Mathematical Economics major, focusing on the theoretical track, and add MATH 304 Statistical Inference Theory. Students undecided among these options are encouraged to contact a member of the coordinating committee.

Mathematical Economics Major

The B.S. **major** in Mathematical Economics requires a total of 18 credits, seven from economics, 10 from mathematics and one culminating experience.

The CCC culminating experience requirement and one W2 requirement will be satisfied with ECON 441 Econometric Research for the Statistical and Theoretical track and with MATH 342 Topics in Finance or Industry for the Computational track.

Required Economics Courses

ECON 101	Economic Principles/Problems	1
ECON 202	Intermediate Mathematical Microeconomics ¹	1
ECON 203	Intermediate Macroeconomics ¹	1
ECON 204	Intermediate Political Economy	1
ECON 241	Econometrics	1
Two economics courses ²		2
Total Credits		7

¹ ECON 202 Intermediate Mathematical Microeconomics and ECON 203 Intermediate Macroeconomics address the information literacy goals of the CCC.

² Selected in consultation with the student's academic adviser. One must be at the 300 level.

Students preparing for graduate studies in economics are strongly encouraged to complete a one-credit senior thesis in economics.

Required Mathematics Courses

MATH 201	Calculus I	1
MATH 202	Calculus II	1
MATH 211	Calculus III	1
MATH 216	Statistics I ³	1
MATH 217	Statistics II	1
MATH 245	Linear Algebra	1
MATH 303	Probability	1
Select one of the following tracks: ⁴		3
Theoretical track		
MATH 280	Logic, Sets, and Proofs	
MATH 308	Real Analysis I	
MATH 345	Advanced Linear Algebra	
Computational track		
CSCI 203	Introduction to Computer Science	

MATH 343	Numerical Analysis
MATH 358	Topics in Operations Research
Statistical track	
MATH 304	Statistical Inference Theory
MATH 358	Topics in Operations Research
MATH 405	Statistical Modeling

Total Credits 10

³ MATH 216 Statistics I addresses the writing goal and the formal presentation goal of the CCC.

⁴ The track is selected in consultation with the academic adviser.

The recommended sequence of courses for students is as follows:

First Year

First Semester	Credits	Second Semester	Credits
ECON 101		1 ECON 202	1
MATH 201		1 MATH 202	1
		MATH 216	1
		2	3

Sophomore

First Semester	Credits	Second Semester	Credits
ECON 203		1 ECON 241	1
MATH 211		1 MATH 245	1
MATH 217		1 MATH 303	1
		3	3

Junior

First Semester	Credits	Second Semester	Credits
ECON 204		1 Economics elective	1
Mathematics track course 1		1 Mathematics track course 2	1
		2	2

Senior

First Semester	Credits	Second Semester	Credits
Second economics elective ⁵		1 Culminating Experience	1
Mathematics track course 3 ⁵		1 ECON 441 (Statistical or Theoretical track)	
		MATH 342 (Computational track)	
		2	1

Total Credits: 18

⁵ Either first semester or second semester.

Please see the Economics section and the Mathematics section of this catalog for a list of courses with course descriptions.

The goal of Bachelor of Science major in Mathematical Economics is to combine the quantitative methods and the theoretical foundations of mathematics with the study of economics to address economic problems. The program learning goals are

1. Demonstrates an understanding of the mathematical tools used in basic and advanced economic modeling.
2. Apply quantitative models and theoretical foundations of mathematics to the study of economic problems.
3. Apply regression and/or applied mathematical models to assess econometric theoretical hypotheses in varied and complex applications.

Economics Courses

ECON 101. Economic Principles/Problems. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

General introduction to both macroeconomics and microeconomics, along with an introduction to economic history, international economics, and political economy. The course also examines the origin of economic ideas in the works of Adam Smith, John Maynard Keynes, Karl Marx, and others.

ECON 104. The Evolution of Economic Ideas and Systems. .25 Credits.**Offered Fall, Spring, Summer; Lecture hours:1**

This course covers how economic ideas evolved alongside changes in economic systems. Topics include the economic thought of Smith, Marx, Veblen, Keynes and Hayek, and economic systems such as ancient communism, empires, feudalism, mercantilism and various forms of capitalism. Students read and write independently on the topic.

ECON 127. International Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An examination of international economic relations today and of the theory used to analyze trade and financial relations. Attention is given to the problems of government policy with respect to international issues. Preference given to IREL majors.

ECON 1NT. Economics Non-traditional Study. 1 Credit.**Offered Fall, Spring, Summer; Lecture hours:Varies,Other:3**

Non-traditional study in economics. Prerequisite: permission of the instructor.

ECON 202. Intermediate Mathematical Microeconomics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Intermediate microeconomic theory of the consumer, the firm, market structures, and resource allocation. Topics are introduced using differential calculus. Prerequisites: (ECON 101 or ECON 103) and (MATH 192 or MATH 201).

ECON 203. Intermediate Macroeconomics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

The study of national income, employment, inflation, interest rates, and the impact of monetary and fiscal policy on the economy. Prerequisite: (ECON 101 or ECON 103) and (MATH 192 or MATH 201).

ECON 204. Intermediate Political Economy. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Intermediate study of Marxist and institutionalist political economy. The ideas of Marx and Veblen applied to such matters as the distribution of income and power, the environment, working conditions, consumerism, and race and gender issues. Prerequisite: ECON 101 or ECON 103.

ECON 210. Introduction to Behavioral Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course introduces students to the field of economics focused on incorporating psychological insights into models of decision making and group interaction. This course provides students with an overview of an assortment of research topics and methods within the field of behavioral economics. Seniors require permission.

ECON 222. Economic Topics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3; Repeatable**

Selected issues in economic theory or policy. Prerequisite: ECON 101 or ECON 103.

ECON 224. African Women & Social Action. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Analysis of topics in films and novels by Ousmane Sembene: pre-colonial history, colonialism, post-colonial independence, racial and gender oppression, worker exploitation, religious conflict, and modernization. Prerequisites: ECON 101 or ECON 103 and permission of the instructor. Crosslisted as WMST 224.

ECON 225. Cultivating Change. 1 Credit.**Offered Summer Session Only; Lecture hours:15,Other:15**

Explores limits to growth and sustainable alternatives. Includes work on an organic farm, and discussions of rhetoric and debates regarding sustainability. Crosslisted as UNIV 224.

ECON 226. Political Economy of the European Integration. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Introduction to core issues and theories related to the economic and political processes of European integration. Offered through Bucknell in London. Crosslisted as POLS 221.

ECON 227. International Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An examination of international economic relations today and of the theory used to analyze trade and financial relations. Attention is given to the problems of government policy with respect to international issues. Prerequisite: ECON 101 or ECON 103 or permission of the instructor.

ECON 230. Data Analysis in Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course provides students with basic skills relating to the locating, downloading, displaying, graphing and analysis of economics data. The course provides instruction in statistical software (STATA) that economists commonly use. Not open to students who have taken ECON 241 or 341. MATH 216 recommended but not required.

ECON 231. Economics of Climate Change. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

This course will first review climate science, sources of climate change, and expected impacts of climate change. Various domestic and international climate policy instruments will be evaluated using economic theories. Special attention will be given to the effect of climate policy on economic development and equity.

ECON 235. African Economic Development. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

A historical, institutional analysis of Sub-Saharan African economic, social, and political development. Primary emphasis will be on the analysis of the economic crisis facing the subcontinent since the late '70s and the structural adjustment programs that have been instituted to deal with the crisis. Prerequisite: ECON 101 or ECON 103.

ECON 236. Gender, Race and Poverty. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

A study of concentrated poverty and unemployment in the United States and policies to generate full employment and eliminate poverty. Prerequisite: ECON 101 or ECON 103 and/or permission of the instructor. Crosslisted as WMST 236.

ECON 237. Health Politics and Health Policy. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

History of health care delivery and financing in the United States and introduction to and evaluation of current topics in health policy. Prerequisite: ECON 101 or ECON 103 or permission of the instructor. First- or second-year standing, others by permission.

ECON 238. Urban Economics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Study of household and business location decisions, and public policies aimed at congestion, pollution, and crime. Prerequisite: ECON 101 or ECON 103. First- and second-year standing, others by permission.

ECON 241. Econometrics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

The application of statistical methods to quantify and test economic theories, analyze government policies, and forecast economic variables. Prerequisites: (ECON 101 or ECON 103) and (MATH 216 or PSYC 215).

ECON 251. Logic Limits Economic Justice. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Investigation of the nature of the "good society" from an economist's point of view, ranging from Right libertarian to anarcho-communist perspectives. Prerequisites: ECON 101 or ECON 103 and permission of the instructor.

ECON 253. Gender and Migration. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Role of gender in internal and international migration flows; economic restructuring; state policies; transnational domestic laborers and sex workers; and migration effects. Prerequisite: ECON 101 or ECON 103. Crosslisted as WMST 253.

ECON 266. Political Economy of Caribbean. 1 Credit.

Offered Fall, Spring or Summer; Lecture hours:3

The development of the Caribbean from colonial times to the present. A look at the social, political, and economic development of the Caribbean as a whole rather than as independent aspects of development.

ECON 268. Migrations: Africa to America and the (Re)Making of Culture. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

This course examines forced and voluntary migrations of Africans and their North American descendants. It will begin with an analysis of west and central African history and will then focus on the period from the beginning of the Trans-Atlantic Slave trade to the present. Crosslisted as AFST 268.

ECON 270. South Africa: Social Entrepreneurship. 1 Credit.

Offered Summer Session Only; Lecture hours:15

The course examines the legacy of apartheid and the role of social entrepreneurship in transforming communities. Students are placed in community organizations in nearby townships. Prerequisite: permission of the instructor. Crosslisted as MSUS 270 and PSYC 270 and UNIV 284 and WMST 275.

ECON 271. The British Economy: Structures and Policies. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Offered as an option for Bucknell in London students. This course will treat a distinct topic relating to British economic affairs.

ECON 273. Latin American Economic Development. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

The course deals with historic and contemporary economic problems, starting from colonial times and reaching the present integration into world economy. Crosslisted as LAMS 273.

ECON 277. The French Economy: Structures and Policies. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Analysis of government planning since 1945. The conflict of liberal and socialist ideologies today. Open to Bucknell en France students only.

ECON 280. Political Economy of Media and Advertising. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Examines the interrelationship of cultural, political, and economic aspects of media content and advertising from the perspective of Institutional and Marxian political economy. Prerequisite: ECON 101 or ECON 103 or permission of the instructor.

ECON 292. Service-Learning in Nicaragua. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

This course focuses on the connections between Nicaraguan development processes and Brigade-based service-learning. Prerequisite: permission of the instructor. Crosslisted as GEOG 292 and IREL 292 and LAMS 292.

ECON 298. Independent Study. .25-1 Credits.**Offered Either Fall or Spring; Lecture hours:Varies,Other:3**

Individual product or project supervised by a member of the economics department typically resulting in the production of a long research paper. Prerequisites: ECON 101 or ECON 103 and permission of the instructor.

ECON 299. Teaching Assistants in Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course can only be taken by economic majors who have permission and have taken the prerequisites. Prerequisites: (ECON 203 or ECON 257) and (ECON 204 or ECON 258) and (ECON 202 or ECON 259) and permission of the instructor.

ECON 2NT. Economics Non-traditional Study. 1 Credit.**Offered Fall, Spring or Summer; Lecture hours:Varies,Other:3; Repeatable**

Non-traditional study in economics. Prerequisite: permission of the department chair or the instructor.

ECON 303. Game Theory. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

"Game Theory" is a set of ideas that help in analyzing strategic situations: situations in which multiple players—individual, groups, nations, organizations, even flora and fauna—interact and pursue their goals in situations of cooperation and conflict. Game theory has been applied to study strategic conflict and cooperation.

ECON 304. Financial Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

The course is focused on theory of finance and asset pricing. Topics include state pricing theory, capital asset pricing model, portfolio theory and risk aversion. Prerequisites: (ECON 202 or ECON 259) and MATH 216.

ECON 308. Economics of Innovation. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course introduces students to the important issues related to technological change and innovation – how new technologies impact the economy and our society. The lectures also focus on economic and social policies aimed at promoting growth and development.

ECON 309. Globalization and Its Implications. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

The course explores opposing economic views on globalization and its effect on the social, cultural, and environmental aspects of life in developed and developing countries. Prerequisites: junior or senior status; (ECON 203 or ECON 257) and (ECON 204 or ECON 258).

ECON 311. Labor Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An examination of economic models related to labor markets, current labor market trends, and the influence of related government policies. Prerequisites: (ECON 202 or ECON 259) and (MATH 216 or MATH 304).

ECON 313. Public Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An analysis of the government's role in the economy. Topics include the economic rationale for government, expenditure analysis, and the allocative and distributive consequences of taxation. It is strongly recommended that students have one semester of statistics. Prerequisite: ECON 202 or ECON 259.

ECON 319. Economic History of Women in the United States. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Examination of the history of women in the U.S. economy, with particular attention to racial-ethnic and class differences among women. Prerequisites: (ECON 203 or ECON 257) or (ECON 204 or ECON 258) or (ECON 202 or ECON 259) and permission of the instructor. Crosslisted as WMST 318.

ECON 320. Race, Economics and Inequality. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Analytically rigorous study of the connections between law, philosophy and policy in the micro and macro economics of racial and social inequality in democratic market societies. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259), and (MATH 192 or MATH 201) or permission of the instructor.

ECON 324. European Economic History. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Development of the market economy and its major institutions. The changing place of the economy in society. Prerequisites: (ECON 203 or ECON 257) or (ECON 204 or ECON 258) or (ECON 202 or ECON 259) or permission of the instructor.

ECON 326. History of Economic Thought. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Discussion of original sources of economic ideas. Readings in Smith, Malthus, Ricardo, Mill, Marx, Jevons, Keynes, and others. Prerequisite: ECON 203 or ECON 257.

ECON 327. International Economic Theory. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

Covers trade theory, tariffs and non-tariff barriers, economic integration, balance of payments, fixed and flexible exchange rates. Not open to students who have taken ECON 427. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259).

ECON 328. Money and Financial Institutions. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3; Repeatable

An analysis of the role of the financial system in the U.S. economy. Topics include determinants of asset prices, risk management, and financial regulations. Prerequisites: (ECON 203 or ECON 257) and (MATH 216 or MATH 226).

ECON 330. Law and Economics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

This course examines several areas of law from the "Law and Economics" perspective and analyzes the assumptions that underlie this approach to law. Property rights law, contract law, and tort law will be covered. Prerequisite: ECON 202 or ECON 259.

ECON 333. Seminar in Economic Topics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3; Repeatable

Guided discussion of economic issues. Topics to be announced at time of preregistration. Prerequisites: (ECON 203 or ECON 257) and (ECON 204 or ECON 258) and (ECON 202 or ECON 259) or permission of the instructor.

ECON 337. International Monetary and Financial Economics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

The course covers balance of payments, foreign exchange markets, international monetary systems, the adjustment mechanism, macroeconomic policy in an open economy and monetary integration. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259) or permission of the instructor.

ECON 339. China & East Asian Economics. 1 Credit.

Lecture hours:3

An analysis of economic transition and development in China, with emphasis on its role in the Asia-Pacific and world economies. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259) or permission of the instructor. Crosslisted as EAST 339.

ECON 342. Methods in Experimental Economics. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

This course provides students with an introduction to methods used in conducting experimental economics research. The course explores different types of experiments (survey/lab/or field) used in economic research, experimental design, and select research topics. Prerequisites: (ECON 202 or ECON 259) and (MATH 216 or MATH 226 or MGMT 102).

ECON 350. Classical Marxism. 1 Credit.

Offered Fall Semester Only; Lecture hours:3

The goal is to develop an understanding of Marx's analysis of capitalism by reading mainly original texts by Marx and consider its applications both to disciplinary thinking and contemporary events. Crosslisted as GEOG 350.

ECON 357. Economic Development. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

The main theories of development; economic and social dualism; agricultural, industrial, and trade strategies; and the role of less developed countries in the emerging global economy. Prerequisites: (ECON 202 or ECON 259) and (ECON 203 or ECON 257) and permission of the instructor.

ECON 358. Marxian Economics. 1 Credit.

Lecture hours:3

Applies Marxian value theory and class analysis to understand contemporary U.S. capitalism. Explains how prices are determined and how competition acts to distribute value, revolutionize technology and working conditions, and trigger economic crises. Explores gender and class in the enterprise and household and examines economic democracy as a viable alternative.

ECON 360. Political Economy of Advanced Capitalism: Economic Crises & Conflict. 1 Credit.

Offered Either Fall or Spring; Lecture hours:3

This course will focus on the structure and the dynamics of the advanced capitalist economies, including the United States. Among other topics, it will examine the empirical evidence and the theoretical claims of the political economy approach concerning economic and financial crises.

ECON 398. Independent Study. .25-1 Credits.**Offered Either Fall or Spring; Lecture hours:Varies,Other:Varies; Repeatable**

Individual study or project, supervised by instructor. Prerequisites: (ECON 203 or ECON 257) or (ECON 204 or ECON 258) or (ECON 202 or ECON 259) and permission of the instructor.

ECON 3NT. Economics Non-traditional Study. .5-2 Credits.**Offered Either Fall or Spring; Lecture hours:Varies,Other:Varies; Repeatable**

Non-traditional study in economics. Prerequisite: Permission of the department chair or the instructor.

ECON 405. Comparative Economic Systems. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

A comparison of the cultures and institutions of modern economic systems. The characteristics of selected capitalist, social democratic and socialist economies are assessed from mainstream, Institutionalist and Marxian analytical perspectives. Prerequisite: ECON 204 or ECON 258 or permission of the instructor.

ECON 406. Recessions and Depressions. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Course explores the main theories of the business cycle that explain the causes of depressions and recessions, and use them to explore the main differences and similarities between the Great Depression and most recent recession. The differences between Keynesian (including New Keynesian) and Monetarist. Prerequisite: ECON 203 or ECON 257.

ECON 410. Risk Management in Financial Markets. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

The course is focused on the applications of finance theory in asset pricing and risk management. The topical coverage will extend to fixed income, equity securities, options, derivatives, risk analysis, and hedging strategies. Prerequisite: ECON 202 or ECON 259 or permission of the instructor.

ECON 412. Health Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Theoretical and empirical examinations of issues in health economics. Course includes semester-long research project on a health topic. Prerequisites: (ECON 202 or ECON 259) and (MATH 216 or MATH 304) or permission of the instructor.

ECON 416. Water Resource Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Examination of economic approaches to managing increasingly scarce water resources and allocating them among competing uses. Demand management strategies like water pricing and water conservation programs, supply enhancements like dams, wells, and water transfers. The valuation of ecosystem goods and services will be explored. Prerequisite: ECON 202 or ECON 259.

ECON 418. American Economic History. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An examination of the development and influence of American economic institutions from colonial to current times. Prerequisites: (ECON 204 or ECON 258) and (ECON 203 or ECON 257) or (ECON 202 or ECON 259).

ECON 420. The British Economic Miracle. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course examines the early British economy and the role it played and continues to play in influencing the modern world. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259) or permission of the instructor.

ECON 422. Experimental Economic Topics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Experimental economics uses researcher-controlled methods to investigate individual and group decision-making. In this course, students will engage with recent scholarly work in experimental and behavioral economics on gender differences in both behaviors and outcomes. The course will primarily focus on those works targeting gender differences in educational and labor markets.

ECON 426. History of Economic Thought. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Discussion of original sources of economic ideas. Readings in Smith, Malthus, Ricardo, Mill, Marx, Jevons, Keynes, and others. Prerequisite: (ECON 257 or ECON 203) and (ECON 258 or ECON 204).

ECON 427. International Economic Theory. 1 Credit.**Offered Fall Semester Only; Lecture hours:3**

Theoretical principles underlying international trade, investment, commercial policy, economic integration, adjustment mechanisms, and balance of payments policy will be examined with an application to current national/international policies. This course isn't open to students that have taken ECON 327. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259).

ECON 429. Political Economy of Financial Crises. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course will explore the causes and consequences of financial crises from macroeconomic perspectives, with most of the attention given to the recent financial crisis in the United States. Prerequisite: (ECON 204 or ECON 258) or permission of the instructor.

ECON 431. Industrial Organization Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Topics include market structure, industrial concentration, firm conduct, mergers, advertising, market performance, examined in the context of U.S. antitrust policy. Prerequisite: (ECON 202 or ECON 259) or permission of the instructor.

ECON 439. China & the World Economy. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

An analysis of economic transition and development in China, with emphasis on its role in the Asia-Pacific and world economies. Prerequisites: (ECON 203 or ECON 257) and (ECON 202 or ECON 259) or permission of the instructor.

ECON 441. Econometric Research. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Advanced panel data methods, instrumental variables and two stage least squares, simultaneous equations, limited dependent variables, sample selection bias, advanced time series, and writing and presenting an empirical research project.

ECON 444. Senior Seminar in Economic Topics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Topics to be announced at the time of preregistration. Prerequisites: (ECON 203 or ECON 257) and (ECON 204 or ECON 258) and (ECON 202 or ECON 259) or permission of the instructor.

ECON 450. Political Economy of Digital Capitalism. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3; Repeatable**

The course examines recent theoretical and empirical debates pertaining to the political economy of digital economic processes and their impact, in turn, on domestic and global development. Prerequisite: (ECON 204 or ECON 258) or permission of the instructor.

ECON 458. Marxian Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Examines the implications of class struggle on microeconomic competition, the distribution of value within and between firms, and macroeconomic instability accumulation and crises at the national and international level. This course isn't open to students that have taken ECON 358. Prerequisite: (ECON 204 or ECON 258) or permission of instructor.

ECON 460. Political Economy of Advanced Capitalism: Economic Crises & Conflict. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

This course will focus on the structure and the dynamics of the advanced capitalist economies, including the United States. Among other topics, it will examine the empirical evidence and the theoretical claims of the political economy approach concerning economic and financial crises.

ECON 499. Honors Thesis in Economics. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3; Repeatable**

Individual research, leading to an honors thesis in economics, undertaken by qualified students, and supervised by an instructor in the department of economics. Prerequisite: permission of instructor and Honors Council.

Mathematics Courses**MATH 112. Introduction to Mathematical Modeling. 1 Credit.****Offered Spring Semester Only; Lecture hours:3**

Introduction for the non-specialist to mathematical modeling of real-world phenomena such as voting and networks, using graph theory, probability, and other accessible tools.

MATH 192. Topics in Calculus. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Elementary calculus and applications taken primarily from economics. Topics include algebraic, exponential, and logarithmic functions, graphs, limits, regular and partial derivatives, constrained optimization, and integration. Not open to students who have MATH 201 credit.

MATH 201. Calculus I. 1 Credit.**Offered Both Fall and Spring; Lecture hours:4**

An introduction to the calculus of algebraic, trigonometric and transcendental functions. Interpretation, significance and calculations of a derivative. Applications to geometry, biology, physics, economics, and other subjects. Introduction to the integral, including the Fundamental Theorem of Calculus and substitution. Not open to students who have MATH 192 credit.

MATH 202. Calculus II. 1 Credit.**Offered Both Fall and Spring; Lecture hours:4**

Methods of integration including integration by parts, numerical approximations, and improper integrals. Sequences, series, including Taylor series. Complex numbers, polar coordinates, parametric functions, differential equations, and applications. Prerequisite: MATH 201.

MATH 203. Introduction to Mathematical Thought. 1 Credit.**Offered Fall Semester Only; Lecture hours:3, Lab:1.5**

An investigation of number, numeration, and operations from the perspective of elementary school teachers and pupils. Open only to B.S. in Education Early Childhood students. Required fieldwork.

MATH 204. Elementary Geometry and Statistics. 1 Credit.**Offered Spring Semester Only; Lecture hours:3,Other:1.5**

Investigation of geometric, probabilistic, and statistical concepts related to elementary mathematics and how children learn and make sense of these concepts. Required fieldwork. Prerequisites: MATH 203 and permission of the instructor.

MATH 207. The Teaching of Mathematics in Secondary Schools. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Other:1.5**

Investigation into the components of effective secondary school mathematics instruction, including lesson design/ implementation (curriculum, tasks, discourse, and assessment). Required fieldwork. Prerequisite: EDUC 201 or permission of the instructor.

MATH 208. Mathematical Explorations. .5 Credits.**Offered Fall Semester Only; Lecture hours:3**

An exploration of topics from pure mathematics, applied mathematics and statistics, illustrating the power and beauty of mathematical reasoning. For students considering a major in mathematics. Corequisites: MATH 201 or MATH 202 or MATH 211 or MATH 212 or MATH 216. Open to first-year students only.

MATH 209. Mathematical Problem Solving. .5 Credits.**Offered Fall Semester Only; Lecture hours:Varies; Repeatable**

Mathematical problem solving, with an emphasis on problems and topics that appear in contests such as the Putnam Competition. Prerequisite: permission of the instructor.

MATH 211. Calculus III. 1 Credit.**Offered Both Fall and Spring; Lecture hours:4**

Calculus of vector-valued functions and functions of several variables. Multiple, line, and surface integrals; applications, and extrema. Green's, Stokes' and Divergence Theorems. Prerequisite: MATH 202.

MATH 212. Differential Equations. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Basic methods of solving ordinary differential equations. Systems of linear differential equations, Laplace transform, applications and selected topics. Prerequisite: MATH 211. Not open to students who have taken MATH 222.

MATH 216. Statistics I. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3,Other:1**

Exploratory data analysis, sampling and experimental designs, sampling distributions and confidence intervals, hypothesis testing, least squares regression, ANOVA, applications. Statistical software is used and a semester long project with real data is undertaken. Not open to students who have MATH 226, MATH 227 or PSYC 215 credit.

MATH 217. Statistics II. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3,Other:1**

Exploratory data analysis, multiple linear regression, analysis of variance and logistic regression. Inferential analysis emphasizing applications to a range of disciplines is conducted using statistical software. Prerequisite: MATH 216 or equivalent. Students who have taken MATH 305 / MATH 405 need instructor's permission to enroll. Crosslisted as MATH 617.

MATH 219. Topics in Applied Mathematics. 1 Credit.**Offered Occasionally; Lecture hours:3; Repeatable**

Topics such as financial mathematics, mathematical biology, cryptography, social networks, etc. Topic varies by semester. Prerequisite: varies by topic.

MATH 222. Differential Equations for Engineers. .5 Credits.**Offered Spring Semester Only; Lecture hours:3**

First order differential equations, second order linear equations, higher order linear equations, numerical approximations. Prerequisite: MATH 211. Open only to civil engineering and environmental engineering students. Not open to students who have MATH 212 credit.

MATH 226. Probability and Statistics for Engineers. .5 Credits.**Offered Fall Semester Only; Lecture hours:3**

Exploratory data analysis, probability theory, discrete and continuous random variables, point estimation, sampling distributions and methods of statistical inference. Statistical software is used. Prerequisite: MATH 202. Open only to engineering students and students in computer science. Not open to students who have MATH 216 credit.

MATH 227. Statistics and Engineering. 1 Credit.**Offered Either Fall or Spring; Lecture hours:3**

Probability theory, discrete and continuous random variables, sampling distributions and methods of statistical inference including regression and ANOVA. Software is used. Prerequisite: MATH 202. Open only to engineering students and students in computer science. Not open to students who have MATH 216 credit.

MATH 230. Data Visualization & Computing. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

Simulation-based learning for concepts including sampling, sampling distributions, p-values, and confidence levels. Data visualization beyond simple exploratory data analysis techniques. Advanced statistical software will be used. Prerequisite: MATH 216 or MATH 227 or permission of the instructor.

MATH 240. Combinatorics and Graph Theory. .5 Credits.**Offered Spring Semester Only; Lecture hours:3**

Counting techniques and traversal problems. Students join MATH 241 mid-semester. Pre- or co-requisite: MATH 280. Only for computer science students or students seeking secondary certification.

MATH 241. Discrete Structures. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

Logic, sets; mathematical induction; relations, functions; combinatorics and graph theory. Not open to students with MATH 280 credit. Prerequisite: MATH 202.

MATH 245. Linear Algebra. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Linear equations, matrices, vector spaces, linear transformations, eigenvalues, inner products, Gram-Schmidt algorithm, singular value decomposition. Prerequisite: MATH 202.

MATH 260. Applications of Calculus to Medicine and Biology. 1 Credit.**Offered Occasionally; Lecture hours:3**

Researchers in biology use mathematical models to design strategies for controlling epidemics, administering drugs, and managing ecosystems. In this class you will learn how to develop your own models, approximate solutions to your models, and compare these solutions to real data. Crosslisted as BIOL 360 or BIOL 662.

MATH 280. Logic, Sets, and Proofs. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Logic, sets; proof techniques; relations, functions, sequences and convergence; cardinality. Skills and tools for independent reading, problem solving and exploration. Prerequisite: MATH 211 or MATH 245.

MATH 291. Undergraduate Readings. .5-2 Credits.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Readings and research in special topics at an intermediate level. Prerequisites: permission of the instructor, adviser, and department chair.

MATH 303. Probability. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Elementary probability, random variables, moments, central limit theorem, conditional expectation, statistical distributions derived from the normal distribution. Probability simulations and applications from various fields. Prerequisite: MATH 211. Crosslisted as MATH 603.

MATH 304. Statistical Inference Theory. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Point and interval estimation, Fisher's likelihood theory, hypothesis testing, simulation techniques. R or SAS will be used. Prerequisites: MATH 216 or MATH 227, and MATH 303, or permission of the instructor. Crosslisted as MATH 604.

MATH 306. Bayesian Statistics. 1 Credit.**Offered Alternating Fall Semester; Lecture hours:3**

Bayesian methods will be introduced including the ideas of prior distributions, likelihood functions, posterior distributions, prediction for common distributions and credible intervals. Advanced statistical software will be used. Prerequisites: MATH 230 and MATH 303, or permission of the instructor. Crosslisted as MATH 606.

MATH 308. Real Analysis I. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Real numbers and elementary topology of Cartesian spaces, convergence, continuity, differentiation, and history of the development of analysis. Prerequisites: MATH 211, MATH 245, and MATH 280.

MATH 311. Theory of Numbers. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3**

Classical number theory in an algebraic setting. Topics include unique factorization, diophantine equations, and linear and quadratic congruences. Advanced topics from algebraic or analytic number theory. Prerequisites: MATH 245 and MATH 280 or permission of the instructor. Crosslisted as MATH 611.

MATH 319. Topics in Advanced Mathematics. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3; Repeatable**

Special topics, to be selected from algebra, analysis, geometry, statistics, applied mathematics, etc. Prerequisite varies by topic. Crosslisted as MATH 619.

MATH 320. Abstract Algebra I. 1 Credit.**Offered Both Fall and Spring; Lecture hours:3**

Groups and rings; homomorphisms and isomorphism theorems; history of the development of algebra. Additional selected topics. Prerequisites: MATH 245 and MATH 280.

MATH 333. Topology. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3**

Topological spaces, connectedness, compactness, continuity, separation, and countability axioms. Metric, product, function, and uniform spaces. Prerequisites: MATH 211 and MATH 280, or permission of the instructor. Crosslisted as MATH 633.

MATH 335. Geometry. 1 Credit.**Offered Fall Semester Only; Lecture hours:3**

Historical and axiomatic foundations of geometry. Euclidean and non-Euclidean geometries. Prerequisite: MATH 280 or permission of the instructor. Crosslisted as MATH 635.

MATH 342. Topics in Finance or Industry. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

Possible topics include industrial mathematics, financial mathematics, genetic algorithms, simulations, and network analysis. Will also include applications to economics and the writing and presenting of a project. Prerequisites: CSCI 203, MATH 245, and MATH 303 or permission of the instructor. Crosslisted as MATH 642.

MATH 343. Numerical Analysis. 1 Credit.**Offered Fall Semester Only; Lecture hours:3,Lab:2**

Floating point arithmetic, development of computational algorithms and error estimates for root approximation, interpolation and approximation by polynomials, numerical differentiation and integration, cubic splines, least-squares, linear systems. Lab component. Prerequisites: MATH 211, CSCI 203, and one of MATH 241, MATH 245, or MATH 280; or permission of the instructor. Crosslisted as MATH 643.

MATH 345. Advanced Linear Algebra. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3**

Systems of linear equations, vector spaces, canonical forms for linear transformations and matrices, bilinear forms, inner product spaces, applications to such other areas as geometry, differential equations, linear programming. Prerequisites: MATH 245 and either MATH 280 or permission of the instructor. Crosslisted as MATH 645.

MATH 350. Methods in Applied Mathematics. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3**

Techniques drawn from partial differential equations, transform methods, Fourier and complex analysis, and variational calculus. Prerequisite: junior or senior status; MATH 212 or permission of the instructor. Crosslisted as MATH 650.

MATH 354. Modern Data Analysis. 1 Credit.**Offered Alternating Fall Semester; Lecture hours:3**

Advanced methods in modern data analysis. Topics may include principal component analysis, random forest, clustering and classification, unsupervised learning, splines, longitudinal data analysis, survival analysis, time series, spatial statistics, and nonparametric methods. Prerequisite: MATH 230 and MATH 245, or permission of the instructor. Crosslisted as Math 654.

MATH 358. Topics in Operations Research. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

Mathematical and statistical techniques in operations research. Queueing theory. Additional topics may include simulation, forecasting, non-linear programming, inventory models. Methods and applications drawn from various fields. Prerequisite: MATH 303 or permission of the instructor. Crosslisted as MATH 658.

MATH 362. Complex Analysis. 1 Credit.**Offered Alternate Fall or Spring; Lecture hours:3**

Limits, analytic functions, integrals including contour integrals. Cauchy's Integral Theorem, entire functions and singularities. Prerequisites: MATH 211 and MATH 280, or permission of the instructor. Crosslisted as MATH 662.

MATH 378. Seminar. .5 Credits.**Offered Either Fall or Spring; Lecture hours:2; Repeatable**

Seminar based on topics from algebra, analysis, topology, differential equations, statistics, or applied mathematics; topics selected according to demand or interest. Prerequisite: permission of the instructor. Crosslisted as MATH 678.

MATH 391. Reading and Research. .5-2 Credits.**Offered Either Fall or Spring; Lecture hours:Varies; Repeatable**

Reading and research in various topics for qualified undergraduate students. Prerequisite: permission of the instructor.

MATH 405. Statistical Modeling. 1 Credit.**Offered Fall Semester Only; Lecture hours:3**

Regression, analysis of covariance, and logistic regression. Model diagnosis and remediation. Model selection, multicollinearity. R or SAS will be used. Prerequisites: MATH 245 and MATH 304. Crosslisted as MATH 605.

MATH 407. Statistical Design of Scientific Studies. 1 Credit.**Offered Spring Semester Only; Lecture hours:3**

Sampling methods for observational studies (simple random, stratified, cluster sampling), and experimental designs (completely randomized, block, crossed, nested, and mixed designs). Estimation procedures, sample size calculations. Uses R or SAS. Prerequisite: MATH 304.

MATH 409. Real Analysis II. 1 Credit.

Offered Alternate Fall or Spring; Lecture hours:3

Continuation of MATH 308. Integration theory and advanced topics in analysis. Prerequisite: MATH 308. Crosslisted as MATH 609.

MATH 416. Modern Applied Mathematics. 1 Credit.

Lecture hours:3

Possible topics include wavelets, harmonic analysis, computational mathematics, nonlinear dynamics, dynamical systems, scientific computing, or cryptography. Prerequisites: MATH 212 and MATH 308, or permission of the instructor. Crosslisted as MATH 616.

MATH 446. Abstract Algebra II. 1 Credit.

Offered Alternate Fall or Spring; Lecture hours:3

Continuation of MATH 320. Advanced topics in group theory including solvable groups, field theory and Galois theory. Prerequisite: MATH 320. Crosslisted as MATH 646.

MATH 491. Reading and Research. .5-2 Credits.

Offered Either Fall or Spring; Lecture hours:Varies; Repeatable

Reading and research in various topics for qualified undergraduates or graduate students at a level appropriate for a Culminating Experience. Prerequisite: permission of the instructor, adviser, and department chair.