

DEPARTMENT OF MATHEMATICS AND ECONOMICS

Mathematics and Economics are integral to daily life and serve as the foundation for a multitude of careers. Our unique and comprehensive program emphasizes quantitative analysis, modeling, and robust business acumen, equipping students to become skilled communicators, critical thinkers, and effective leaders.

Our esteemed faculty includes some of the nation's foremost analytical minds, many of whom are members of prestigious academic and professional organizations. They bring extensive industry experience and cutting-edge research into the classroom. As dedicated educators and mentors, they challenge and inspire students to apply their knowledge beyond academic settings.

We believe that learning extends beyond the classroom. By supporting academic clubs and organizations and fostering connections with industry partners, we provide students with real-world experiences and networking opportunities. Our interdisciplinary approach ensures that students are well-prepared for successful careers in a variety of fields: economics, actuarial mathematics, applied statistics, data

Major, our Applied Statistics concentration and our Applied Statistics Minor.

Faculty

Department Chair

Gao Niu

Professor

Laura Beaudin
Economics

Professor

Aziz Berdiev
Economics

Professor

James Bishop
Actuarial Science

Professor

Rick Gorvett
Actuarial Science

Professor

Jongsung Kim
Economics

Professor

Sam Mirmirani
Economics

Professor

Ramesh Mohan
Economics

Professor

John T. Quinn
Actuarial Science

Professor

Richard M. Smith
Actuarial Science

Professor

Edi Tebaldi
Economics

Associate Professor

Son Nguyen
Mathematics

Associate Professor

Gao Niu
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Associate Professor

Xiaofei "Sophia" Pan
Economics

Assistant Professor

Yahong "Yvette" Feng
Mathematics

Assistant Professor

Dekun "Jessica" Zhai

Actuarial Science

Senior Lecturer

Louise Hasenfus
Mathematics

Senior Lecturer

Allison Kaminaga
Economics

Senior Lecturer

Karen Pitts
Mathematics

Lecturer

Farzana Alamgir
Economics

Lecturer

Mengqi Deng
Mengqi Deng

Lecturer

William H. Zywiak
Mathematics

Visiting Assistant Professor

Ferdous Sardar
Economics

Applied Analytics Courses

AA 205. Introduction to Applied Analytics. 3 Credit Hours.

This is an introductory course in applied analytics. The focus is on using data and being able to gain insight into the data for multiple purposes. Analytics will be studied from a wide variety of fields and disciplines including using data visualization, text mining, and data mining methodologies to investigate questions related to the arts, business, humanities, social and physical sciences. The insight students gain may assist them in making effective decisions or the insight may be derived from analyzing textual data that were previously not thought to be significant.

Prerequisites: MATH 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AA 304. Managing Information for Applied Analytics. 3 Credit Hours.

This course is about the management of information, how it is acquired, stored, and deployed effectively and how it may be analyzed for applications in a wide variety of domains such as literary and historical text analysis, social media, bioinformatics and business decision making. With the technology of today, we can gather data sets from many sources, some that are so large and complex (Big Data) that using traditional database management tools becomes difficult. Information management today must also deal with huge amounts of unstructured data that is being generated by social media in blogs, tweets, videos, speech, photographs, e-mails, and others. Not only are we faced with the challenge of how to store all of this data, but how we can effectively extract relevant information and visualizations from these disparate sources and gain valuable insights. This course brings together several key technologies-- databases, data warehouses, and large distributed data repositories--in a project that demonstrates how data can be stored, manipulated, and visualized.

Prerequisites: AA 205

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AA 306. Data Mining for Effective Decision Making. 3 Credit Hours.

In very simple terms, analytics is about the discovery and communication of meaningful patterns in data. This course is about applying analytics to create useful information that provides insights, fosters inquiry, and supports effective decision making and problem solving. It follows that the target audience for this course is anyone who anticipates having a need for useful information during their career and in their personal life. The approach taken in this course is that analytics is a tool that may be applied to achieve a desired outcome. Without a clear purpose or objective, the use of analytical methodologies is nothing more than a fishing expedition. It also follows that even when a clear objective is present, the application of analytics is only useful if the results of the analysis lead to reasoned action. Therefore, this course is more than a review of analytical methodologies. It is also about understanding problems, setting objectives, critical thinking and interpreting results. Problems will be addressed in a variety of disciplines including applications in liberal arts, science and business.

Prerequisites: AA 205

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AA 490. Applied Analytics Capstone. 3 Credit Hours.

In AA 490, students complete a comprehensive real-world data project along with a presentation to the class and other interested parties of key aspects of the project with an analysis of the results. This will be a learning experience that gives students the opportunity to conduct real-world data preparation and analysis using data in a field relating to their primary area of concentration or major. Students will need to understand the problem, and then clean and analyze the data. The scope of the project is not only to complete a well-defined piece of work in a professional manner, but also to place the work into the context of an analytics environment by applying current state of the art techniques.

Prerequisites: AA 205, AA 304, AA 306, junior standing or permission of the instructor

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

Actuarial Mathematics Courses

AM 230. Actuarial Statistics I. 3 Credit Hours.

This is the first course in probability and statistics for actuarial students. Topics include sample spaces, probability rules, counting techniques, Bayes rule, random variables, probability distributions and density functions, expected values and moment generating functions, and special probability distributions and densities.

Pre/Corequisites: MATH 223

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AM 231. Actuarial Statistics II. 3 Credit Hours.

This course is a continuation of AM 230. Topics include transformation of variables; sampling distributions and order statistics, the central limit theorem; max likelihood estimates; method of moment estimates and hypothesis testing.

Prerequisites: MATH 223 and AM 230

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AM 332. Actuarial Statistics III. 3 Credit Hours.

This course is an applied statistics course for actuaries. It covers the topics necessary for analysis of data. Topics include: Hypothesis testing, chi-square tests, Analysis of Variance, Simple and Multiple Regression, Time Series and Index Numbers.

Prerequisites: AM 231 or MATH 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AM 333. Advanced Probability. 3 Credit Hours.

This course is devoted to the study of distribution classes and credibility. It is designed to prepare actuarial students for many of the topics covered in Exam STAM given by the Society of Actuaries. The topics of study include Risk Measures, Distribution Families, Coverage Modifications, Frequentist and Bayesian Estimation, and Credibility Theory. This course includes both theoretical analysis as well as applied problems that arise naturally in the insurance industry.

Prerequisites: AM 231

Session Cycle: Fall

Yearly Cycle: Annual.

AM 340. Mathematical Interest Theory I. 3 Credit Hours.

This course includes the measurement of interest; accumulation and discount of money; present value of a future amount; forces of interest and discount; equations of value; investment return; inflation; annuities (simple and complex); perpetuities; amortization and sinking funds; yield rates; spot and forward rates; and bond pricing. This course is designed to help prepare the student for Exam FM.

Prerequisites: MATH 223

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AM 341. Mathematics of Finance, Insurance, and Pensions. 3 Credit Hours.

This course will review the mathematics of basic compound interest for determining the future amounts and present values of single and periodic investments. Advanced topics in the mathematics of finance will include complex annuities of fixed periodic amounts, annuities where the periodic payment amount increases arithmetically and/or geometrically, bonds, including duration analyses, investment rates of return, both dollar- and time-weighted, and reverse mortgages. Topics in the mathematics of insurance will include the development of mortality tables and computation functions for the determination of the present and accumulated values of life annuities, premium determination, and settlement payment options. Topics in the mathematics of pensions will include the mathematics of social security, defined benefit and defined contribution pension plans. Students receiving credit for AM 340 or AM 421 will not receive credit for this course.

Prerequisites: MATH 110 or equivalent

Session Cycle: Fall

Yearly Cycle: Alternate Years.

AM 342. Mathematical Interest Theory II. 3 Credit Hours.

This course, combined with Mathematical Interest Theory I, prepares students for Exam FM given by the Society of Actuaries. The topics cover fundamental actuarial theory as it pertains to interest and investments. This course includes mathematical valuation of securities and dividends; options, put-call parity, duration, evaluation and payoff and profit of derivative contracts, forwards, futures, and swaps. Additional topics include immunization and cash flows. This course not only helps the student prepare for Exam FM, but it also helps provide a cross-over in preparing for Exam IFM and 3F.

Prerequisites: AM 340

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

AM 391. Actuarial Math Internship. 3 Credit Hours.

Actuarial mathematic internships give students the opportunity for supervised employment in an area where they can apply actuarial mathematic theories and principles. Interns work at least ten hours a week, meet periodically with supervising faculty member, do research on their field of employment, and prepare a substantive report on work experience and research.

Prerequisites: Junior standing and approval by a supervising faculty member and the department chair.

AM 393. Exam P Seminar. 2 Credit Hours.

The goal of this course is to help students synthesize content from AM 230 (and some content from AM 231) and apply that knowledge to solving actuarial problems such as those encountered in the context of Exam P. In addition this course will also develop students computational skills and tacit knowledge of problem-solving strategies needed to tackle these actuarial problems in an efficient manner. While additional study effort will be required, passing this course should put students on track for taking Exam P.

Pre/Corequisites: AM 231

Session Cycle: Spring

Yearly Cycle: Annual.

AM 394. Exam FM Seminar. 2 Credit Hours.

The goal of this course is to help students synthesize content from AM 340 (and some content from AM 342) and apply that knowledge to solving actuarial problems such as those encountered in the context of Exam FM. In addition this course will also develop students computational skills and tacit knowledge of problem-solving strategies needed to tackle these actuarial problems in an efficient manner. While additional study effort will be required, passing this class should put students on track for taking Exam FM.

Pre/Corequisites: AM 342

Session Cycle: Fall

Yearly Cycle: Annual.

AM 421. Life Contingencies I. 3 Credit Hours.

This course is a study of single life functions including the measurement of mortality; life annuities; life insurance; and net annual premiums. This course, in conjunction with AM 422, is designed to help prepare actuarial students for Exam LTAM given by the Society of Actuaries.

Prerequisites: AM 230 and AM 340

Session Cycle: Fall

Yearly Cycle: Annual.

AM 422. Life Contingencies II. 3 Credit Hours.

A continuation of AM 421, including net premium reserves; gross premium reserves including expenses; joint-life functions; contingent functions; compound contingent functions; reversionary annuities; and multiple decrement functions. The course provides a theoretical basis of contingent payment models and the application of those models to insurance and other financial risks. This course, in conjunction with AM 421, is designed to help prepare actuarial students for Exam LTAM given by the Society of Actuaries.

Prerequisites: AM 421

Session Cycle: Spring

Yearly Cycle: Annual.

AM 423. AI Application in Insurance. 3 Credit Hours.

This course explores the application of modern data analytics and Artificial Intelligence (AI) in the insurance industry. Structured into three modules, it begins with foundational skills in data handling and analysis, focusing on "big data" and advanced techniques like classification trees, cluster analysis, and neural networks. The second module applies these tools to risk management, including risk modeling, loss exposure analysis, and risk control. The third module focuses on insurance-specific applications such as underwriting, loss reserving, and ratemaking. Through hands-on projects, case studies, and collaborative learning, students develop critical thinking, quantitative analysis, and communication skills. Designed for Actuarial Mathematics majors and Business minors, this course bridges data science, AI, and insurance, preparing students for careers in a rapidly evolving industry.

Prerequisites: Sophomore Standing

Session Cycle: Every Fall.

AM 440. Actuarial Mathematical Models and Stochastic Calculus. 3 Credit Hours.

The primary goal of this course is to provide the student a background in the mathematics of stochastic processes, risk, and financial economics as it relates to actuarial models. The underlying foundation of this course is the mathematics and economics of the pricing of financial options. The course will cover the theoretical basis of corporate finance and financial models, and it will highlight the application of those models to insurance and other financial risks. Taking this course will make it possible for the student to prepare for the Society of Actuaries Exam IFM and the Casualty Actuarial Society Exam 3F.

Prerequisites: AM 342 or FIN 465

Session Cycle: Fall

Yearly Cycle: Annual.

AM 451. Pension Fundamentals. 3 Credit Hours.

This one-semester course is designed to introduce the student to the social security system of the United States and to various deferred compensation concepts including defined benefit, defined contribution, target benefit, and profit sharing pension plans. Both the accumulation and distribution of pension funds are discussed via annuities certain and life annuities. Appropriate aspects of the Internal Revenue Code which govern deferred compensation will be discussed.

Prerequisites: One of the following: MATH 129, AM 340 or AM 341 or FIN 312

Session Cycle: Fall

Yearly Cycle: Annual.

AM 471. Fundamentals of Property and Casualty Reserving. 3 Credit Hours.

The reserve for unpaid claim liabilities is a major item on the balance sheet of every property and casualty (P&C) insurer. Estimating this quantity is a core responsibility of actuaries. This course will cover basic mathematical and accounting concepts relating to reserving, the triangular loss development, deterministic reserve projection methods (e.g., loss-ratio and Bornhuetter-Ferguson techniques), common diagnostic statistics, characteristics of different US P&C lines of business, and GLM-based stochastic reserving methods, that utilize bootstrapping.

Prerequisites: AM 332

Session Cycle: Spring

Yearly Cycle: Annual.

AM 481. Ratemaking. 3 Credit Hours.

This course will cover the basic techniques of property and casualty ratemaking. Ratemaking is corefunction of actuaries, and is a necessary tool for satisfying an organization's strategic, operational, and regulatory goals and requirements. This course will cover much of the material on the ratemaking portion of the syllabus for Exam 5 of the Casualty Actuarial Society (CAS).

Prerequisites: AM 231 and AM 340 and junior standing

Session Cycle: Fall

Yearly Cycle: Annual.

AM 492. Advanced Actuarial Mathematics Seminar Exam LTAM. 2 Credit Hours.

The goal of this course is to help students synthesize content from the two life contingencies courses (AM 421 and AM 422), and apply that knowledge to solving actuarial problems such as those encountered in the context of the Society of Actuaries' Exam LTAM. In addition, this course will also develop the students' computational skills and tacit knowledge of problem-solving strategies needed to tackle these actuarial problems in an efficient manner. While additional study effort will be required, passing this course should put the student on track for taking Exam LTAM.

Pre/Corequisites: AM 422

Session Cycle: Varies

Yearly Cycle: Varies.

AM 493. Advanced Actuarial Mathematics Seminar Exam STAM. 2 Credit Hours.

The goal of this course is to help students synthesize content on probability and stochastic modeling topics from the following courses: AM 231, AM 332, and AM 333. The synthesized knowledge will be applied to solving actuarial problems such as those encountered in the context of Exam STAM. In addition this course will also develop your computational skills and tacit knowledge of problem solving strategies needed to tackle these actuarial problems in an efficient manner. While additional study effort will be required, passing this course should put students on track for taking Exam STAM.

Pre/Corequisites: AM 333

Session Cycle: Varies

Yearly Cycle: Varies.

Economics Courses**ECO 113. Microeconomic Principles. 3 Credit Hours.**

This course introduces students to the basic principles of microeconomics, including the nature and method of economics and the role of the private and government sectors. Emphasis is placed on the firm, market structures, and resource allocation.

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

ECO 114. Macroeconomic Principles. 3 Credit Hours.

Students in this course learn the basic principles of macroeconomics, including national income accounting, business cycles, income determination, and monetary and fiscal problems and policy. Also considered is international economics, including trade, comparative advantage theory, balance of payments, exchange rates, and trade and finance problems and policy.

Session Cycle: Fall, Winter, Spring

Yearly Cycle: Annual.

ECO 201. Money and Banking. 3 Credit Hours.

Unlike the real side of the economy, which is the actual conversion of resources into consumption, the financial system produces no tangible good that can be used to directly satisfy some need or want. Yet, no modern economy can exist without a well functioning financial system. The financial system impacts real economic activity by providing (1) ways to transfer economic resources through time, across geographic regions, and among industries, (2) ways to manage risk, (3) ways of clearing and settling payments to facilitate the exchange of goods, services and assets, (4) a mechanism for the pooling of funds to undertake large scale indivisible enterprise, (5) price information that helps coordinate decentralized decision making, and (6) ways to deal with the incentive problems when one party to a financial transaction has information that the other party does not, or when one party is an agent that makes decisions for another. This course will explore the financial system and its functions. Topics covered include the basic principles of money, credit and banking, their relation to prices and business fluctuations, the Federal Reserve System, monetary policy, and international macro-finance.

Prerequisites: ECO 114

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

ECO 210. Research Methods in Economics. 3 Credit Hours.

Research Methods in Economics introduces students to the mathematical, statistical, programming, technical writing, and public speaking skills necessary to comprehend and conduct meaningful economic research. Students will be introduced to topics such as mathematical optimization, data analysis, regression, and writing techniques used to understand and analyze complex economic problems. In addition, students will complete an individual and unique research project to solidify the concepts learned throughout the course of the semester to prepare them for upper level courses in economics. Note:

Applied Economic majors must take ECO 210 before taking ECO 315. All other students that took ECO 315 first cannot receive credit for ECO 210.

Prerequisites: Either ECO 113 or ECO 114, and MATH 201 and sophomore standing

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 213. Economics of Social Issues. 3 Credit Hours.

The course objectives are to increase the student's knowledge and interest in the economic consequences of social issues and to provide the student with the basic analytical skills needed to assess social problems from an economics perspective. Students will learn how to determine the appropriate economic principles which, when applied, might bring about the reduction or resolution of particular social issues.

Prerequisites: ECO 113 or ECO 114

Session Cycle: Summer

Yearly Cycle: Varies.

ECO 310. Mathematical Economics. 3 Credit Hours.

Mathematical economics refers to the application of mathematical methods to represent economic theories and analyze problems posed in economics. The purpose of this course is to equip students with the mathematical tools needed for economic analysis which are unlikely to be taught in other classes. The course has four major goals: i) review mathematical tools of algebra and calculus; ii) introduce analysis of differential and difference equations; iii) introduce matrix algebra; and iv) introduce static optimization including the concept of duality.

Prerequisites: ECO 113 or ECO 114 and MATH 110 or MATH 121 or instructor permission

Session Cycle: Spring

Yearly Cycle: Alternate Years.

ECO 313. Intermediate Microeconomics. 3 Credit Hours.

In this course, the behavior of business firms will be studied through an investigation of demand, supply and equilibrium under conditions of perfect and imperfect competition in the product market. Similar analytical techniques are then employed to examine the efficient allocation of the factors of production.

Prerequisites: ECO 113

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

ECO 314. Intermediate Macroeconomics. 3 Credit Hours.

This course examines macroeconomics concepts and problems. Students will develop the analytical capability to determine how aggregate demand and aggregate supply are influenced by the public and private sectors as measured by changes in employment, inflation, national output, and international trade. An analysis will also be made of the impact of selected macroeconomic policies that employ classical and Keynesian recommendations for increasing real national output while maintaining price stability.

Prerequisites: ECO 114

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

ECO 315. Econometrics. 3 Credit Hours.

This course is an introduction to basic econometric techniques and strongly emphasizes on statistical applications to economic theories. Students consider problems in estimating such economic variables as consumption-income-price relationships, production functions as well as problems in simulating economic models. For data analysis, students will learn to use Stata and/or R. Applied Economics majors must take ECO 210 before taking ECO 315.

Prerequisites: ECO 113 or ECO 114 and MATH 110 and MATH 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

ECO 316. Strategic Game Theory and Applications. 3 Credit Hours.

We explore the fundamental principles of game theory and apply them to a range of strategic interactions involving two or more decision makers like individuals, firms, and political entities in a strategic manner. Key concepts such as dominance, backward induction, Nash equilibrium, commitment, credibility will be analyzed through classroom games and real-world applications in economics, business, politics, and beyond. Emphasizing critical thinking and problem-solving, the course combines theoretical analysis, interactive exercises, and real-world case studies to deepen students' understanding of strategic decision-making.

Pre/Corequisites: ECO 113

Session Cycle: Every Fall Semester.

ECO 340. Sports Economics. 3 Credit Hours.

This course applies microeconomic principles and theories to the sport industry. The core microeconomic fields of Industrial Organization, Public Finance and Labor Markets are the focus of this course to examine professional and college sports. Topics of particular interest are but not limited to sports franchises and profit maximization, monopoly behavior and union role, salary determination, and discrimination, cost-benefit analysis, investment decisions on stadiums and teams.

Prerequisites: ECO 113

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 350. America and the Free Market. 3 Credit Hours.

The influence of the free market philosophy in the U.S. extends far beyond the market place or the economic arena. This course examines these influences and the consequences of the adoption of free market economics on many aspects of U.S. society including its influence on the economy, political economy, politics, socio-economic policies, education, culture, and media among others. There is a particular focus on the relationship between the ideals of free markets and democracy.

Prerequisites: ECO 113

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 363. Industrial Organization: American Industry. 3 Credit Hours.

Industrial Organization is concerned with the way markets and industries are structured and the behavior and performance of firms in those markets and industries. Topics to be covered in this course include oligopoly, pricing strategies, research and development, barriers to entry, and advertising. Specific industries such as steel, autos, and computers will be examined.

Prerequisites: ECO 113

Session Cycle: Fall

Yearly Cycle: Alternate Years.

ECO 364. Industrial Organization: Government and Business. 3 Credit Hours.

The emphasis in this course is on the application of economic concepts and tools to evaluate the effectiveness of government antitrust laws and regulatory practices in bringing about a more competitive economic system. Topics include price fixing, predatory pricing, and price determination. The origins and tasks of Federal and State Regulatory Commissions are also examined.

Prerequisites: ECO 113

Session Cycle: Fall

Yearly Cycle: Alternate Years.

ECO 367. Economic Development. 3 Credit Hours.

An analysis of developing nations. Areas covered include characteristics of developing countries; economic, social, and political problems; foreign aid and trade; the role of governments; human and non-human capital formation; and some case studies of individual countries.

Prerequisites: ECO 114

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 391. Economics Internship. 3 Credit Hours.

Economics internships give students the opportunity for supervised employment in an area where they can apply economic theories and principles. Interns work at least ten hours a week, meet periodically with a supervising faculty member, do research on their field of employment, and prepare a substantive report on their work experience and research. Approval required by a supervising faculty member and the department chair.

ECO 393. Managerial Economics. 3 Credit Hours.

This course is concerned with how economic principles and methodologies can assist managers in business and other organizations to make decisions. Areas of analysis include, but not limited to, supply and demand, production and cost, market structures and pricing, economics of information and managerial strategies, and the role of government in the market place.

Prerequisites: ECO 113

Session Cycle: Summer

Yearly Cycle: Annual.

ECO 397. Directed Study in Economics. 3 Credit Hours.

ECO 397 enables students (sophomores, juniors and seniors) to do an independent study of a specialized topic with an economics faculty member.

ECO 413. Applied Microeconomics: Case Studies. 3 Credit Hours.

This course, with its case study focus, examines the application of microeconomic theories to real business and industry environments.

Issues of supply and demand, market structures, government intervention, and resource markets are among a few of the topics of discussions and analyses.

Prerequisites: ECO 113 and ECO 114 and junior standing

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 414. Applied Macroeconomics: Case Studies. 3 Credit Hours.

This course covers core issues in macroeconomics at an advanced level. Topics covered will include long term growth, short term fluctuations and policy issues. The course centers on macroeconomic practical applications and issues by integrating case studies and journal articles.

The overall goal is to gain a broad and critical understanding of models that can help to analyze specific policy issues in the global environment.

Prerequisites: ECO 113, ECO 114 and ECO 314 and junior standing

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 415. Applied Econometrics for Business and Policy. 3 Credit Hours.

A fundamental problem faced by decision makers is to obtain solid empirical evidence to support or reject their propositions. Consequently, markets and governments are increasingly demanding professionals who can apply sophisticated statistical tools to obtain empirical evidence that can be used to analyze complex problems and make decisions.

Applied Econometrics for Business and Policy is designed to apply modern methods of empirical analysis to the task of making informed choices related to business and policy projects. It is a hands-on-the-data course that gives to students practice and the tools to analyze a variety of economic and business problems.

Prerequisites: ECO 113 and ECO 114 and ECO 315 or FIN 311 or or MATH 350 or AM 332

Session Cycle: Fall

Yearly Cycle: Alternate Years.

ECO 440. Machine Learning Applied to Economics. 3 Credit Hours.

The dawn of the artificial intelligence era is disrupting both markets and the traditional framework for applying economics. This course offers an introduction to the economics of machine learning – computational algorithms that provides the ability to automatically learn from the data and improve from experience without being explicitly programmed – and explores the application of machine learning to make predictions and improve decision-making. Lectures, class discussion, guest speakers, and team projects will be used to expose students to a variety of topics and questions including: how machine learning makes prediction better? What data-based predictions are important to business and decision-makers? How to find relevant tasks to apply machine learning to solve economic problems? What are the off-the-shelf applications of machine learning (applications in analyzing text and images) that can be applied to economic decision-making?

Prerequisites: ECO 113, ECO 114, and one of the following: ECO 315, MATH 201, ISA 201, or ISA 221

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 445. Experimental Economics. 3 Credit Hours.

This course provides an introduction to experimental methods in economics. In other economic courses, you have learned about economic theories. In this class, we will learn the methodology for testing those theories. Either we will be able to confirm the theories or we will find evidence that the theories are incorrect, usually because they are based on a questionable assumption. Students will also become familiar with state-of-the-art research methodology in experimental economics, and will learn to conduct their own research projects by participating in and designing experiments in bargaining, auction markets, and other economic situations.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 450. Current Affairs of East Asian Economy. 3 Credit Hours.

This course will encourage discussions of a variety of current economic issues in East Asian economy. To understand how three East Asian nations (China, Japan and Korea) have followed different economic development paths students will learn economic growth and development theories as well as their historical backgrounds. Within these theoretical frameworks, students will develop analytical skills to better understand the economic growth and development mechanism in the global setting. Students will also study how these economies have been affected by globalization.

Prerequisites: ECO 114 and sophomore standing

Session Cycle: Fall

Yearly Cycle: Varies.

ECO 461. Environmental Economics. 3 Credit Hours.

This course develops and uses microeconomic principles to better understand current environmental issues. Attention is given to the efficient use of environmental resources. Various public policies dealing with environmental problems such as acid rain, global warming and air and water pollution are discussed and analyzed. International comparisons regarding environmental policy is incorporated.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Spring

Yearly Cycle: Alternate Years.

ECO 462. Public Finance. 3 Credit Hours.

This course examines the role of the federal government in the market when there are market failures. The course focuses on issues surrounding the efficient allocation of resources, the existing distribution of income and policies designed to stabilize the economy. The fundamentals of the personal income tax and social security tax are outlined and the impact on economic behavior is discussed. Similarly, federal expenditures for health, social security, education, and welfare are evaluated.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Spring

Yearly Cycle: Alternate Years.

ECO 463. Labor Economics. 3 Credit Hours.

This course deals with a discussion of a variety of economic topics in the labor market. To understand how the labor market works, students will learn labor economic theories such as theories of labor supply, labor demand, and human capital. With theoretical frameworks, students will be able to better understand and examine government policies toward the labor market. Students will also study how the U.S. labor market is affected by globalization.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Fall or Spring

Yearly Cycle: Annual.

ECO 464. Behavioral Economics and Applications. 3 Credit Hours.

This course analyzes the observed behavior of decision makers and explores when and why actual behavior deviates from the predictions of standard economic models. Drawing from research in psychology and economics, the course enriches standard economic theories by incorporating social, cognitive and emotional factors into decision-making models. These factors include (but are not limited to) bounded rationality, altruism, reciprocity, cooperation, procrastination and self-control, and individual decisions under uncertainty. The course also discusses the policy implications of behavioral models as they relate to savings, tax policies, health care industry and financial industries.

Prerequisites: ECO 113 and ECO 114 and sophomore standing

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 471. International Trade. 3 Credit Hours.

International Trade offers a broad overview of international economic theory and its application to analyze real world events. A wide range of issues will be discussed including comparative advantage, gains from trade, protectionism, the effects of trade on economic performance and income inequality, the balance of payments, and major issues of finance. It will also examine political and economic development. By the end of the course students should be able to i) analyze and interpret international trade issues; ii) apply basic concepts of international economics to analyze current events and policy topics, and iii) critically evaluate the impacts of international trade on society's well-being.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 473. Economics of Health and Medical Care. 3 Credit Hours.

This course will examine economic processes in the health care industry of the United States. It provides the student with an understanding of how decisions are made by providers, consumers, and the third party payers for pricing and the quantity of healthcare services. This course will cover decision-making models, analyze policy issues and investigate political and economic aspects of the health care industry. Among the topics covered are market mechanism and structures, government intervention, health care reform and insurance, and ethics in health care.

Prerequisites: ECO 113 and ECO 114

Session Cycle: Fall

Yearly Cycle: Alternate Years.

ECO 480. Economic Growth Policy and Practice. 3 Credit Hours.

The factors determining long-term economic growth have been a major concern for economists and governing bodies for many years. The general purpose of this course is to begin to discover what is known about the determinants of long-run economic growth. The course has three major specific goals: i) briefly look and discuss the historical record related to cross-country economic growth; ii) introduce students to the economics of growth and examine how economic theory explains the actual growth record of the world's countries; and iii) apply economic growth models to investigate topics of special interest to students.

Prerequisites: ECO 113 and ECO 114 and junior standing

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 481. The Fed Challenge. 3 Credit Hours.

The course prepares students for the College Fed Challenge, an academic competition to be held at the Boston Federal Reserve District Bank in November. Students research and analyze economic and financial conditions and then present and defend their analyses with recommendations for monetary policy before a panel of judges.

Prerequisites: ECO 113, ECO 114, permission of the instructor and sophomore standing.

Prerequisites: ECO 113 and ECO 114, sophomore standing and permission of the instructor

Session Cycle: Fall

Yearly Cycle: Annual.

ECO 490. Capstone Economics Seminar. 3 Credit Hours.

This senior level capstone seminar is designed for students majoring in economics to explore specific economic research topic of their interest, either as part of a weekly seminar or as an individual directed study. This course requires students to apply and analyze economic analysis. Where applicable they will be required to present their research paper before economics faculty and students.

Prerequisites: Economics major or concentrator and senior standing

Session Cycle: Spring

Yearly Cycle: Annual.

ECO 497. Directed Study in Economics. 3 Credit Hours.

ECO 497 Enables economics majors/concentrators to do an independent in-depth research or study of an advanced topic under the direction of a member of the Economics Department. The main requirement is the development of a professional quality paper (or other demonstration of mastery of the material.).

Prerequisites: ECO 113 and ECO 114.

Mathematics Courses

MATH 101. Pre-Calculus. 3 Credit Hours.

MATH 101 is a pre-calculus course. Topics covered will include linear functions, power functions, graphical concepts, quadratic functions, rational functions, and exponential and logarithmic functions. In addition, there will be an extensive review of algebraic concepts. It is expected that, upon completion of this course, students will be prepared to take MATH 110. This course does not fulfill a Mathematics requirement.
Session Cycle: Fall
Yearly Cycle: Annual.

MATH 110. Mathematical Analysis. 3 Credit Hours.

MATH 110 is an applied mathematics course that presents a mathematical way of thinking and provides students with experiential opportunities to explore how to quantitatively analyze complex problems. Four general areas are covered: a review of mathematical functions and their applications; the mathematics of finance; creation, use, and interpretation of models involving real-world data; and linear programming and optimization. Applications are relevant for sustainability issues, business and management, economics and finance, and the social and natural sciences. Students will be placed, by the Math Department, in the appropriate course based on standardized testing and previous math course performance.

MATH 121. Calculus and Analytic Geometry I. 3 Credit Hours.

This is the first course for Actuarial Mathematics, Applied Math and Statistics, Applied Economics, Biology and Environmental Science majors, and those concentrating in Applied Statistics. The course is also recommended for the math minors. Topics include limits, continuity, derivatives, and integrals, along with their application to the Mean Value Theorem, curve sketching and optimization, the calculus of transcendental functions, and area between curves.
Session Cycle: Fall, Spring
Yearly Cycle: Annual.

MATH 122. Calculus and Analytic Geometry II. 3 Credit Hours.

This course is a continuation of MATH 121, designed for Actuarial Mathematics, Applied Math and Statistics, Applied Economics, Biology and Environmental Science majors, and those concentrating in Applied Statistics. It is recommended for the math minors also. Topics include L'Hopital's Rule, the calculus involving inverse trigonometric functions, integration methods, modeling with differential equations, geometric series, MacLaurin and Taylor Polynomials and Series, introduction to partial derivatives and multiple integrals.
Prerequisites: MATH 121
Session Cycle: Fall, Spring
Yearly Cycle: Annual.

MATH 129. Mathematics of Finance. 3 Credit Hours.

This course is an intensive study of mathematics that can be applied in business and finance. Topics include simple and ordinary interest, simple bank discount, compound interest, simple and complex annuities, annuities in perpetuity, and geometrically varying annuities. The mathematics for determining present value, future amount, and periodic annuity payments is developed. Further, the concepts of exponential and logarithmic functions are presented in order to be able to determine time duration. The students are shown interest rates in annuities, which cannot be determined explicitly by algebraic methods but can be determined by use of Goal Seek function in Excel. Fundamental linear programming and breakeven models (that include time delayed revenue and borrowed funds) are also presented. Students that receive credit for MATH 110 or MATH 110 Honors cannot receive credit for MATH 129.
Session Cycle: Fall
Yearly Cycle: Annual.

MATH 201. Statistics I. 3 Credit Hours.

In this course, students are taught the concepts necessary for statistical analysis and inference, in the context of real-world-type data analysis and modeling. Topics include descriptive statistics, classical probability, probability distributions, confidence intervals, and hypothesis testing, chi-square analysis, simple linear regression, and correlation. One or more case studies, accompanied by references to survey creation and data collection, provide experiential opportunities for students. Students will be placed, by the Math Department, in the appropriate course based on standardized testing and previous math course performance.

MATH 202. Biostatistics. 3 Credit Hours.

This course serves as an introduction to applying statistical thinking to biological problems. Topics include numerical and graphical summaries of data, basic probability concepts, sampling distributions, basic concepts for estimation, estimation for population means and proportions, basic concepts for hypothesis testing, hypothesis tests for population means and proportions, analysis of variance, sample size calculations, inferences from two samples, correlation and regression.
Session Cycle: Every Semester.

MATH 203. Sports Statistics I. 3 Credit Hours.

This course provides a fundamental understanding of basic probability and statistics with a focus on sports applications. Methods and theory behind commonly used statistics will be applied in a sports setting. As an aid in statistical analysis, Excel "Data Analysis" functions will be used. All major US sports will be considered as well as selected international sports. Assignments will often allow the student to study a sport of their own choosing. Fantasy sports, betting, and e-sports will also be considered where applicable.
Session Cycle: Every Semester.

MATH 223. Calculus and Analytic Geometry III. 3 Credit Hours.

This course is the third of three calculus courses required of actuarial and applied mathematics and statistics majors. Topics include the conic sections, circles, parabolas, ellipses, and hyperbolas, polar coordinates, vectors and vector-valued functions, functions of more than one variable dealing with partial derivatives with its mathematical applications and the calculation of double and triple integrals.
Prerequisites: MATH 122
Session Cycle: Fall, Spring
Yearly Cycle: Annual.

MATH 226. Linear Algebra. 3 Credit Hours.

This course is an introduction to the topic of Linear Algebra. The topics covered will include the study of matrices, determinants, vector spaces, subspaces, row and column spaces, null spaces, linear transformations, and eigenvalues and eigenvectors.
Prerequisites: MATH 121
Session Cycle: Fall, Spring
Yearly Cycle: Annual.

MATH 228. Discrete Structures. 3 Credit Hours.

This course introduces the foundations of discrete mathematics as they apply to information technology, focusing on providing a solid theoretical foundation for further work. Topics include propositional logic, sets, growth of functions, simple proof techniques, elementary number theory, counting techniques, relations and graph theory.
Pre/Corequisites: MATH 110 or equivalent
Session Cycle: Spring
Yearly Cycle: Varies.

MATH 350. Statistics II. 3 Credit Hours.

A continuation of MATH 201, this course provides students further concepts necessary for statistical analysis and inference. Topics include analysis of variance, multiple regression and correlation, model building, chi-square tests, and nonparametric statistics.

Prerequisites: MATH 201

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

MATH 354. Software Application for Mathematics. 3 Credit Hours.

This course introduces students to the use of Microsoft Visual Basic behind Excel spreadsheets. Students are taught to write computer programs based on specified criteria. Excel functions and Goal Seek are used in a variety of applied project assignments. Topics typically include simulation, mathematical distributions, and statistical analyses. Additional topics may include writing of stand-alone programs with Visual Basic forms, manipulation of data in Excel or Microsoft Access, and/or the use of statistical packages such as SAS.

Prerequisites: MATH 201 or AM 230

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

MATH 391. Applied Mathematics and Statistics Internship. 3 Credit Hours.

Applied mathematics and/or statistics internships give students the opportunity for supervised employment in an area where they can apply their theories and principles. Interns work at least ten hours a week, meet periodically with a supervising faculty member, conduct research on their field of employment, and prepare a substantive report on work experience and research.

Prerequisites: Junior standing and approval by a supervising faculty member and the department chair.

MATH 409. Elementary Number Theory. 3 Credit Hours.

This course will cover topics such as divisibility, prime numbers, Fundamental Theorem of Arithmetic, Euclid's Algorithm, Pascal's Triangle, Fibonacci numbers, congruences and residue classes, Diophantine equations, Euler's Phi Function, Fermat's Last Theorem, and Pythagorean Triples. A major application in the course will be to Cryptography. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 201 or permission of the instructor

Session Cycle: Spring

Yearly Cycle: Annual.

MATH 421. Statistical Analysis With R. 3 Credit Hours.

This course covers the application of R in a wide range of subjects in data analysis. The statistical topics include descriptive statistics; hypothesis testing; probability distribution; Bayesian statistics; predictive modelling; and unsupervised learning. Students will also learn how to write functions in R, Rmarkdown, and various R famous packages such as ggplot2, caret, mosaic, dplyr.

Prerequisites: MATH 350 or AM 332

Session Cycle: Fall

Yearly Cycle: Annual.

MATH 435. Geometry. 3 Credit Hours.

Since the time of Euclid (330 BC) the study of Geometry has been regarded as a foundation of western education and the preferred context in which to teach young adults the purpose and value of logical thinking. This course is offered to provide undergraduate and graduate level mathematics education students and others an introduction to and a mastery of both the classical and analytic aspects of Euclidean Geometry. The ideas of point, line, plane, triangle, quadrilaterals, parallelism and lack of it, similarity, congruence, area, volume and Loci will be formally presented through an axiomatic method using definitions, postulates and geometric proofs. The structure, the pedagogy and the presentation of the above topics will also be emphasized throughout the course. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 110 or permission of instructor

Session Cycle: Spring

Yearly Cycle: Varies.

MATH 455. SAS Programming and Applied Statistics. 3 Credit Hours.

This course provides an introduction to SAS programming. It also covers statistical applications utilizing both SAS and Enterprise Guide. Some of the topics covered in the first part of this course include: reading raw data files and SAS data sets; investigating and summarizing data by generating frequency tables and descriptive statistics; creating SAS variables and recoding data values; subsetting data; combining multiple SAS files; creating listing, summary, HTML, and graph reports; managing SAS data set input and output, working with different data types, and manipulating data. In the second part of the course, we apply SAS and Enterprise Guide to the analysis of data using the topics of ANOVA, regression, and logistic regression. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 350 or AM 332 or ECO 210 or ECO 315

Session Cycle: Spring

Yearly Cycle: Annual.

MATH 456. Statistical and Mathematical Decision Making. 3 Credit Hours.

This course provides an introduction to the concepts and methods of Decision Science, which involves the application of mathematical modeling to problems of decision making under uncertainty. It also provides a foundation in modeling with spreadsheets. Topics include linear programming, goal programming, nonlinear programming, decision analysis, and simulation.

Prerequisites: MATH 201 or AM 231

Session Cycle: Spring

Yearly Cycle: Varies.

MATH 460. Applied Data Mining. 3 Credit Hours.

Employing SAS Enterprise Miner software with real-world case studies, this course introduces students to the current theories, practices, statistical tools and techniques in "data mining," which embodies cutting-edge methods to reveal competitive insight, market advantage, and strategic opportunities. This course will cover the most useful statistical tools in data mining such as cluster analysis, logistic regression, classification trees, and neural networks. In addition, a comprehensive real-world data project will be required along with a presentation to the class and other interested parties of key aspects of the project with an analysis of the results. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 350 or AM 332

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

MATH 461. Applied Multivariate Statistics. 3 Credit Hours.

After a brief review of multiple regression and analysis of variance, students are introduced to multivariate statistical techniques including principal components analysis, factor analysis, cluster analysis, discriminant analysis, logistic regression and multivariate analysis of variance. This course will emphasize practical applications rather than theory. The computer package SAS will be used for analysis. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 350 or AM 332

Session Cycle: Fall, Spring

Yearly Cycle: Annual.

MATH 470. Statistical Design and Analysis of Experiments. 3 Credit Hours.

This course is an introduction to the design and analysis of statistical experiments. It will cover the main elements of statistical thinking in the context of experimental design and ANOVA. Students will learn to choose sound and suitable design structures and also how to explore real data sets using a variety of graphs and numerical methods and analyze these data sets from designed experiments and reach justifiable conclusions based on the analyses. This will be an applied course and will utilize the SAS statistical package. This is a SAS Certified class. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 350 or AM 332

Session Cycle: Fall

Yearly Cycle: Annual.

MATH 475. Applied Analytics Using SAS. 3 Credit Hours.

This course will include an in-depth review of applied analytical approaches, challenges, and solutions. A hands-on approach will be emphasized throughout the semester. A brief review of analytical techniques through material covered in MATH 350 or AM 332 will be included, as well as an introduction to further analytical tools such as multivariate analysis, predictive modeling, time series analysis and survey analysis. The SAS statistical package will be utilized for applying hand-on analysis to real world data problems. This is a SAS Certified course. For qualified students, this course may be taken as a 500 level graduate content course. Permission of the instructor is required.

Prerequisites: MATH 350 or AM 332

Session Cycle: Spring

Yearly Cycle: Annual.

MATH 488. Sports Statistics. 3 Credit Hours.

This course introduces a number of statistical methods beyond the elementary level and combines theory with application. The goal is for the student to develop the ability to compare and contrast a number of statistical methods focusing on their application to the sports industry. A major component of this course is to understand the strengths and weaknesses of various statistical methods.

Prerequisites: AM 231 or MATH 350

Session Cycle: Spring

Yearly Cycle: Annual.

MATH 490. Applied Mathematics and Statistics Capstone Seminar. 3 Credit Hours.

The students will be required to research and write an applied mathematical or statistical thesis, and make oral presentations of the results. This course will develop the student's research skills and ability to write and present applied mathematical or statistical topics. Projects that solve problems of an interdisciplinary nature are encouraged.

Prerequisites: Senior standing and permission of the instructor

Session Cycle: Spring

Yearly Cycle: Annual.

MATH 497. Directed Study in Mathematics. 3 Credit Hours.

This is an opportunity for students to do independent, in-depth research for academic credit. The student works on an individual basis under the direction of a member of the mathematics department. The main requirement of the course is the development of a substantial paper or project.

MATH ST300. Special Topics in Mathematics Mathematics of the Arts and Creativity. 3 Credit Hours.

This applied Mathematics course will consist of a comprehensive review of the mathematical underpinnings of visual art, music, and creativity (and to a lesser extent architecture). Mathematics will include, geometry, base 7, base 8, fractals, and differential equations. Course assignments will include using the open access programming software R to generate a fractal image or fractal video. This course is designed to enhance the student's appreciation and understanding of Math and the Arts, and to facilitate the student's creating new visual art and music by using mathematical approaches. This course may also help students develop more engaging presentations (eye-catching visuals/ear-catching audio).

Prerequisites: AM 231 or MATH 201 or permission of the instructor

Session Cycle: Fall

Yearly Cycle: Annual.

MATH ST310. Spec. Topics in Mathematics: Culture, History, Business Environment, and Analytical Research Aboard. 3 Credit Hours.

This course studies the cultural, history, and business environment of Japan. Multiple analytical research projects will be carried out throughout the trip, including business culture study, population and aging study, US-Japan economics analysis, climate change impact in east Asia, insurance risk overview, and analytics study. Students are also required to complete an after-trip comprehensive paper with a topic of their choice. This course will count towards one of the 3 advanced topics in actuarial mathematics for actuarial math major or one of the 3 advanced electives for applied mathematics and statistics major.

Session Cycle: Fall Semester.