DEPARTMENT OF MATHEMATICS AND ECONOMICS

The Mathematics Department, through academic excellence, provides the theoretical foundation for critical thinking in quantitative problem solving and reasoning. We help students to develop their ability to effectively communicate mathematics. The Department prepares students for success in a career in actuarial mathematics, applied mathematics, applied statistics, or a profession of their choice.

Economics Programs

Mathematics Programs

SAS-Bryant University Academic Specialization in Data Mining

By satisfactorily completing four SAS-based statistics courses, undergraduate students at Bryant University will achieve a Tier 3 (Top Tier) SAS Academic Specialization in Data Mining. Students with this specialization develop the skills and knowledge required to solve real-world problems by applying mathematical principles. The students also develop an understanding of mathematical and statistical concepts along with computer skills for business applications.

The four SAS courses can satisfy requirements in our Applied Mathematics and Statistics major, our Applied Statistics concentration, and our Applied Statistics minor. For our Applied Statistics minors, only one additional course beyond the minor is necessary to complete the SAS Specialization requirements. In order to receive the Specialization, a student must achieve at least a B average in all these courses with no grade lower than a C in any one course.

- **SAS Data Mining Certificate Program**
- **SAS-Bryant University Academic Specialization In Data Mining**

Faculty

Department Chair:
Rick Gorvett

Professor
James Bishop
Mathematics

Professor
Rick Gorvett
Mathematics

Professor
Jongsung Kim
Economics

Professor
Sam Mirmirani
Economics

Professor
Ramesh Mohan
Economics

Professor
John T. Quinn
Mathematics

Professor
Richard M. Smith
Mathematics

Professor
Edi Tebaldi
Economics

Associate Professor
Laura Beaudin
Economics

Associate Professor
Aziz Berdiev
Economics

Associate Professor
Son Nguyen
Mathematics

Associate Professor
Gao Niu
Mathematics

Associate Professor
Xiaofei "Sophia" Pan
Economics

Assistant Professor
Ferdous Z. Sardar
Economics

Senior Lecturer
Nanci Beausoleil
Mathematics

Senior Lecturer
Louise Hasenfus
Mathematics

Lecturer
Allison Kaminaga
Economics

Lecturer
Karen A. Pitts
Mathematics

Lecturer
William H. Zywiak
Mathematics

Executive in Residence
James Wood
Mathematics

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 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 triangluar 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.

AM 494. Advanced Actuarial Exam Seminar IFM and 3F. 2 Credit Hours.
The goal of this course is to help students synthesize content on options (AM 342 or FIN 481) and stochastic calculus (AM 440), and apply that knowledge to solving actuarial problems such as those encountered in the context of Exam IFM and 3F. 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 IFM and 3F.
Pre/Corequisites: AM 440
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 Economic 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 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 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 functons, 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 s 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 E110. Mathematical Analysis. 3 Credit Hours.
MATH 110 is an applied mathematics course. Although it is weighted more heavily toward calculus and its applications, many pre-calculus topics will be reviewed prior to the corresponding calculus topic. Topics covered will include differentiation, integration, curve sketching and optimization techniques. Applications are keyed to management, economics, finance, and the social and natural sciences. A brief unit on Mathematics of Finance will also be covered. This course meets five days a week.
Prerequisites: Math Placement exam
Session Cycle: Fall, Spring
Yearly Cycle: Annual.

MATH E201. Statistics I. 3 Credit Hours.
In this course students are taught the concepts necessary for statistical analysis and inference. Topics include descriptive statistics, classical probability, probability distributions, confidence intervals, and hypothesis testing, chi-square analysis, simple linear regression and correlation. This course meets five days a week.
Prerequisites: MATH 110 or equivalent
Session Cycle: Fall, Spring, Summer
Yearly Cycle: Annual.

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.