DEPARTMENT OF MATHEMATICS AND STATISTICS

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Department Chair:
Majid Bani-Yaghoub

Emeriti Faculty:

Professors:
Kamel Rekab, Noah H. Rhee, Liana Sega, Yong Zeng

Associate Professors:
Eric Hall, Majid Bani-Yaghoub

Teaching Professor:
Richard Delaware

Assistant Teaching Professor:
Nadeesha Mawella, Said Shehab

Assistant Professors:
Xianping Li

Lecturers:
Kristin Kathman, Stephanie Van Rhein

Department Description
The Department of Mathematics and Statistics offers coursework leading to the Bachelor of Arts and Bachelor of Science degrees in Mathematics. At the graduate level, the department offers a Master of Science degree in Mathematics and a Master of Science degree in Statistics, and participates in the UMKC School of Graduate Studies Interdisciplinary Ph.D. program. Qualified students can select Mathematics as the coordinating unit or a co-discipline when applying for admission or preparing their plans of study. See the School of Graduate Studies (http://catalog.umkc.edu/colleges-schools/graduate-studies/mathematics) section in the Graduate Catalog for more information about the Ph.D. program.

These programs are designed to develop the student's own knowledge of mathematics or statistics, and to provide the tools and understanding necessary for the study of other scientific and quantitative fields.

The Department of Mathematics and Statistics has an institutional membership in the American Mathematical Society.

Advising System
Advising is on an individual basis with senior mathematics faculty members. Appointments for advising may be made by contacting the department, the undergraduate advisor, the principal graduate advisor, or the interdisciplinary Ph.D. coordinator.

Library Resources
In addition to UMKC's Miller Nichols Library, the department has full access to the holdings and services of the Linda Hall Library of Science and Technology (http://www.lindahall.org), a privately endowed institution of international prominence. The Linda Hall Library subscribes to more than 700 mathematics journals and maintains a large and growing collection of mathematics books.
Faculty

Majid Bani-Yaghoub Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=bani); assistant professor of mathematics; Ph.D. (Carleton University, Canada).

Richard Delaware Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=delaware); teaching professor of mathematics; B.S. (Santa Clara University); M.A. (University of Kansas); Ph.D. (University of Missouri - Kansas City).

Eric J. Hall Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=hall); associate professor of mathematics; B.A. (Carleton College); Ph.D. (University of Michigan).

Kristin Kathman Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=van%20rhein); lecturer in mathematics; B.S., M.S. (University of Missouri - Kansas City).

Xianping Li Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=li); assistant professor of mathematics; Ph.D. (University of Kansas).

Kamel Rekab Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=rekab); professor of statistics; M.S. (Stanford University); Ph.D. (University of Michigan).

Noah H. Rhee Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=rhee); professor of mathematics; B.S. (Seoul National University, South Korea); Ph.D. (Michigan State University).

Liana Sega Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=sega); associate professor of mathematics; B.S. (University of Bucharest, Romania); Ph.D. (Purdue University).

Stephanie Van Rhein Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=van%20rhein); lecturer in mathematics; B.S., M.S. (University of Missouri - Kansas City).

Hristo D. Voulov Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=voulov); associate professor of mathematics; M.S., Ph.D. (Sofia University, Bulgaria).

Yong Zeng Contact Information (https://cf1.umkc.edu/intapps/lookup/?LastName=zeng); professor of statistics; B.S. (Fudan University, China); M.S. (University of Georgia); Ph.D. (University of Wisconsin - Madison).

Associate or Adjunct Graduate Faculty

Members of UMKC Graduate Faculty

Members of UMKC Doctoral Faculty

Undergraduate

Undergraduate Degrees:

- Bachelor of Arts in Mathematics and Statistics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/ba-mathematics-statistics)
- Bachelor of Science in Mathematics and Statistics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/bs-mathematics-statistics)
- Minor in Actuarial Science (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/minor-actuarial-science)
- Minor in Mathematics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/minor-mathematics)
- Teacher Certification in Mathematics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/teacher-certification-mathematics)

Graduate

Graduate Degrees:

- Master of Science in Mathematics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/master-of-science-mathematics)
- Interdisciplinary Ph.D. in Mathematics (http://catalog.umkc.edu/colleges-schools/arts-sciences/academic-departments-programs/mathematics-statistics/interdisciplinary-phd-mathematics)
Mathematics Courses

MATH 109 Precalculus Algebra Fundamentals Credits: 2
This course is required for students not meeting full placement requirements for MATH 110 (Precalculus Algebra) in order to concurrently enroll in MATH 110. Fundamental topics and skills that are necessary for success in MATH 110 will be developed in close alignment with the material covered in MATH 110 over the course of the semester. Students enrolling in this co-requisite course must remain enrolled in both courses for the semester. Students will not be permitted to withdraw from one of the courses (either MATH 109 and MATH 110) and not the other. Grades are not counted toward GPA. Does not fulfill Arts and Sciences mathematics requirement. Does not count toward graduation.

Prerequisites: ALEKS score of 35 or higher, or ACT mathematics score of 18 or higher.

Co-requisites: MATH 110.

MATH 110 Precalculus Algebra Credits: 3
Functions and graphs. Inverses, compositions, and transformation of functions. Solving equations, systems of equations, and inequalities. Linear, quadratic, polynomial, and rational functions. Exponential and logarithm functions and applications.

Prerequisite: MATH 100 with a grade of B- or higher, ALEKS score of 51 or higher, ACT mathematics score of 22 or higher, or concurrent enrollment in MATH 109.

MATH 110 - MOTR MATH 130: Pre-Calculus Algebra

MATH 115 Statistical Reasoning Credits: 3
This course is intended for majors in less quantitative fields. The focus of the course will be on developing critical thinking abilities and decision making using data in everyday life. Emphasis will be on statistical reasoning underlying the methods of sampling, statistical inference in terms of evaluating the accuracy of an estimate in the context of uncertainty, drawing conclusions from data and studying relationships in data. Students will be trained to perform hands-on-analysis of real data sets using a computer package. No previous computing experience is required.

MATH 116 Mathematics For Liberal Arts Credits: 3
A survey of elementary mathematics covering such topics as: logic, sets, counting methods, introduction to probability theory, introductory statistics, plane and coordinate geometry. The course will emphasize mathematical concepts and does not require the level of computational skill of College Algebra. Topics from the history of mathematics will be presented as well as the influence of mathematics on a variety of disciplines. Recommended preparation: Three units of high school mathematics Algebra I and higher.

MATH 116 - MOTR MATH 120: Mathematical Reasoning Modeling

MATH 120 Precalculus Credits: 5
Functions and graphs. Inverses, compositions, and transformation of functions. Solving equations and systems of equations, and inequalities. Linear, quadratic, polynomial, and rational functions. Exponential and logarithm functions and applications. Trigonometric functions, trigonometric identities, triangles. Credit will be given for either MATH 110 or MATH 120, and for either MATH 120 or MATH 125.

Prerequisite: ALEKS score of 56 or higher, or ACT mathematics score of 24 or higher.

MATH 120 - MOTR MATH 150: Pre-Calculus

MATH 125 Trigonometry Credits: 2
Trigonometric functions, trigonometric identities, triangles, and complex numbers. Credit will be given for either MATH 120 or MATH 125.

Prerequisites: MATH 110 with a grade of C- or higher, or ALEKS score of 63 or higher.

MATH 125 - MOTR MATH 150: Pre-Calculus

MATH 130 Mathematics For Teachers: Number Systems Credits: 3
Designed for elementary school teachers. A constructive development of the real number system beginning with the system of whole numbers; concepts from elementary number theory; applications of quantitative systems to problems in discrete mathematics. Recommended preparation: High school algebra and geometry.

MATH 140 Mathematics for Teachers: Elementary Geometry Credits: 3
Designed for elementary school teachers. A development from informal geometric concepts to elements of the Euclidean deductive system; groups of congruence transformations, similarity transformations and symmetries; coordinate systems and vectors. Recommended preparation: High school algebra and geometry.

MATH 202 Analytic Geometry Credits: 3
Coordinate plane, lines, circles, the parabola, the ellipse, the hyperbola, transformation of coordinates, equations of the second degree, curve sketching, polar coordinates and parametric equations, complex numbers, vectors and vector operations, and solid analytic geometry. Recommended preparation: MATH 110.
MATH 204 Mathematics for Teachers: Mathematical Immersion Credits: 3
Adaptable for elementary-, middle-, or secondary-school mathematics teachers. Intensive problem solving experience. Develop confidence and enthusiasm about recognizing mathematics reasoning in oneself and in students. Combat mathematics anxiety and myths. Encourage flexibility in the mathematical knowledge of teacher candidates. Recommended preparation: MATH 120 or MATH 130 or MATH 140 or any MATH course 200 level or above.

MATH 205 Discrete Mathematics Credits: 3

MATH 206 Brief Calculus And Matrix Algebra Credits: 3
Brief review of selected topics in algebra. Introduction to matrix algebra. Introduction to differential calculus and optimization. Applications to problems in business.
Prerequisites: MATH 110 (C- or higher), or ALEKS assessment score of 63% or higher.

MATH 210 Calculus I Credits: 4
Functions and graphs, rational, trigonometric, exponential functions, composite and inverse functions, limits and continuity, differentiation and its applications, integration and its applications.
Prerequisites: MATH 120 or both MATH 110 and MATH 125 (all with a grade of C- or higher), or ALEKS score of 76 or higher.

MATH 214 Mathematics for Teachers: Algebra Credits: 3
Designed for middle school mathematics teachers. Algebraic reasoning, patterns and inductive reasoning, arithmetic and algebra of integers, algebraic systems, algebraic modeling in geometry, axiomatic mathematics. Recommended preparation: MATH 110, MATH 130, MATH 140 (or MATH 224).

MATH 216 Calculus for Biological Sciences Credits: 4
Introductory calculus designed for students in health and biological sciences. Topics include functions, limits and continuity, trigonometric functions, differentiation and its applications, integration, mathematical modeling, and discrete dynamical systems. Group projects are an integral part of this course. Credit will not be given for both MATH 216 and MATH 210.
Prerequisites: MATH 120 or both MATH 110 and MATH 125 (all with a grade of C- or higher), or ALEKS score of 76 or higher.

MATH 220 Calculus II Credits: 4
Techniques of integration, applications of the definite integral, improper integrals, sequences and series, power series. Taylor series and convergence, analytic geometry in calculus. Recommended preparation: MATH 210 or MATH 216.

MATH 224 Mathematics for Teachers: Geometry Credits: 3
Designed for middle school mathematics teachers to connect middle school and college mathematics. Geometric reasoning, Euclidean geometry, congruence, area and volume, similarity, rigid motions and symmetry, vectors and transformations, some other geometries. Recommended Preparation: MATH 140.

MATH 226 Biomath II: Statistics and Modeling Credits: 3
Calculus-based statistics and modeling designed for students in the biological sciences or mathematics majors interested in the application of mathematics to these sciences. Topics include introductory ordinary differential equations, continuous dynamical systems, stochastic modeling, elementary probability, random variables, binomial distributions, Poisson distributions, normal distributions, point estimation, confidence intervals, hypothesis testing, ANOVA, and regression. Credit will be given for either MATH 226 or STAT 235 (or STAT 236). Recommended preparation: MATH 210 or MATH 216.

MATH 250 Calculus III Credits: 4
Vectors, solid analytic geometry, vector functions and multiple variable functions, partial derivatives, multiple integrals, line and surface integrals with applications.
Prerequisites: MATH 220 or MATH 268.

MATH 266 Accelerated Calculus I Credits: 4
An accelerated first course in calculus focusing on application of differential calculus and basic vector and matrix calculations. Enrollment in this course requires permission from the School of Computing and Engineering.
Prerequisites: Departmental consent.

MATH 268 Accelerated Calculus II Credits: 3
An accelerated second course in calculus focusing on application of integral calculus, analytic geometry, and vector analysis.
Prerequisites: MATH 266; School of Computing Engineering Student.

MATH 300 Linear Algebra I Credits: 3
Linear equations, matrix algebra, real vector spaces, linear transformations, determinants, eigenvalues and eigenvectors, orthogonality, and applications.
Prerequisites: MATH 250, (or MATH 220 and COMP-SCI 191).
MATH 301 On Solid Ground: Sets and Proof Credits: 3
This course is a transition from procedural mathematics, such as calculus, to advanced mathematics where proofs are the professional language of discourse. It covers basic set theory and logic, relations and functions, and how to analyze, construct, and write clearly reasoned, well-structured elementary proofs using universal techniques. This course satisfies a state requirement for teacher certification.
Prerequisites: MATH 220.

MATH 345 Ordinary Differential Equations Credits: 4

MATH 402 Advanced Analysis I Credits: 3
Numerical sequences and completeness of the real numbers, numerical series, continuity and differentiation of real-valued functions of a real variable, integration and the fundamental theorem of calculus.
Prerequisites: MATH 250, MATH 301.

MATH 406 Partial Differential Equations Credits: 3
Separation of variables, boundary value problems, Fourier series and integrals, wave equation, heat equation, potential equation, problems in several dimensions, and Bessel's differential equation.
Prerequisites: MATH 345 (or E&C-ENGR 241, or MEC-ENGR 272).

MATH 407 Introduction to Complex Variables Credits: 3
Complex numbers, complex differentiation, elementary functions, contour integration and the Cauchy integral formula, Taylor series and Laurent series, residue calculus and its applications, and special functions.
Prerequisites: MATH 250 and MATH 300 (or MATH 301 or MATH 345 or E&C-ENGR 241 or MEC-ENGR 272).

MATH 410 Modern Algebra Credits: 3
Groups, rings, integral domains, fields and polynomial rings.
Prerequisites: MATH 300, MATH 301.

MATH 412 Advanced Analysis II Credits: 3
Topics in advanced analysis such as sequences and series of functions, power series and elementary functions, Fourier series, metric spaces, analysis in Euclidean spaces, or advanced integration.
Prerequisites: MATH 402.

MATH 414 Mathematics for Secondary Teachers: Algebra and Analysis Credits: 3
Designed for secondary-school teachers. Examine high school mathematics from a higher point of view. Real and complex numbers, functions, algebraic structures of equations, integers and polynomials, number system structures; analyses of alternate approaches, extensions, and applications of mathematical ideas, discussion of historical contexts and connections between ideas that may have been studied separately in different courses, relationships of ideas studied in secondary-school to those students may encounter in later study. When taken for graduate credit as MATH 5514, an extra project is required. Recommended preparation: MATH 300 and MATH 301.

MATH 420 Linear Algebra II Credits: 3
The topics of MATH 300 are expanded and presented in the context of vector spaces over a field, with rigorous justification. Vector spaces and linear transformations, determinants, eigenvalues and eigenvectors, inner product spaces and orthogonality.
Prerequisites: MATH 300, MATH 301.

MATH 424 Mathematics for Secondary Teachers: Geometry Credits: 3
Designed for secondary-school teachers. Examine high school mathematics from a higher point of view. Congruence, distance and similarity, trigonometry, area and volume, axiomatics and Euclidean geometry; analyses of alternate approaches, extensions, and applications of mathematical ideas, discussion of historical contexts and connections between ideas that may have been studied separately in different courses, relationships of ideas studied in secondary-school to those students may encounter in later study. When taken for graduate credit as MATH 5524, an extra project is required. Recommended preparation: MATH 300 and MATH 301.

MATH 430 Numerical Analysis I Credits: 3
Error analysis, solutions of equations of one variable, interpolation and polynomial approximation, numerical integration and differentiation, numerical solutions of initial-value problems. Recommended preparation: MATH 250 or E&C-ENGR 241 or MEC-ENGR 272.

MATH 434 Introduction to Scientific Computing Credits: 3
This course provides a comprehensive introduction to numerical methods used in scientific computing. It focuses on solving math models arising from other fields such as physics, engineering, biology, and economics. The topics include mathematical foundations, numerical linear algebra, finite difference method, finite volume method, finite element method, and parallel computing. Recommended preparation: MATH 300.

MATH 440 Numerical Analysis II Credits: 3
Direct and iterative methods for solving linear systems, introduction to approximation theory, approximating eigenvalues and eigenvectors, solution of systems of nonlinear equations. Recommended preparation: MATH 300 and MATH 430.
MATH 444 Modern Geometries Credits: 3
Modern axiomatic development of Euclidean geometry and neutral geometry, followed by examination of non-Euclidean geometries; geometric transformations, and other geometries as time permits. Satisfies a state requirement for teacher certification. Recommended preparation: MATH 300 and MATH 301.

MATH 464WI History Of Mathematics Credits: 3
Topics in the History of Mathematics from Babylonian times through the invention and consolidation of Calculus, with some modern subjects as time permits. The course will emphasize proofs, ideas, and arguments as given in original sources (in translation) from around the world and throughout history. In this writing intensive course, one or two term papers, in addition to several short essays and historical proof explications are required. A field trip will be taken to the Linda Hall Library Rare Book Room. This course is of special interest to secondary mathematics teachers as well as mathematics majors. Recommended preparation: MATH 301.
Prerequisites: RooWriter.

MATH 469 Mathematical Modeling Credits: 3
This course introduces analytical and numerical techniques for modeling and analysis of real-world problems in areas such as economics, engineering, biology and physics. It is designed for students with basic knowledge of linear algebra and differential equations. Interdisciplinary modeling projects are the integral part of this course. Recommended preparation: MATH 300 and MATH 345.

MATH 490 Special Topics Credits: 1-3
Selected topics in various fields of mathematics. May be repeated for credit when the topic varies.

MATH 496 Internship/Practical Training in Mathematics or Statistics Credits: 1-3
This course provides an internship or other practical training arrangement using mathematics or statistics in an industrial, academic or other professional setting. Department approval of internship experience or practical experience required. Repeatable with up to a combined 3 credits toward the major. Recommended preparation: MATH 250.

MATH 5509 General Algebra I Credits: 3
Groups, rings, modules, homology, fields and Galois theory, valuations, matrices, and multilinear algebra. Continued in MATH 5519.
Prerequisites: MATH 410, MATH 420.

MATH 5510 Complex Variables I Credits: 3
The group of linear fractional transformations, complex integration, Cauchy's theorem, the maximum modulus theorem, analytic continuation, Riemann surfaces. Continued in MATH 5520.
Prerequisites: MATH 402, MATH 407.

MATH 5513 Real Variables I Credits: 3
Prerequisites: MATH 402, MATH 412.

MATH 5514 Mathematics for Secondary Teachers: Algebra and Analysis Credits: 3
Designed for secondary-school teachers. Examine high school mathematics from a higher point of view. Real and complex numbers, functions, algebraic structures of equations, integers and polynomials, number system structures; analyses of alternate approaches, extensions and applications of mathematical ideas, discussion of historical contexts and connections between ideas that may have been studied separately in different courses, relationships of ideas studied in secondary-school to those students may encounter in later study. When taken for graduate credit as Math 5514, an extra project is required.
Prerequisites: MATH 300.

MATH 5517 Matrix Theory I Credits: 3
Unitary matrices, normal matrices, Jordan canonical form, nonnegative matrices and their applications, the symmetric eigenvalue problem.
Prerequisites: MATH 420.

MATH 5519 General Algebra II Credits: 3
Prerequisites: MATH 5509.

MATH 5520 Complex Variables II Credits: 3
Prerequisites: MATH 5510.

MATH 5521 Differential Equations Credits: 3
This course offers an introduction to the qualitative theory and applications of ordinary differential equations (ODE). The presentation of the course will be a blend of fundamental theory and examples. The basic results will be proved rigorously and more advanced results will be only illustrated by examples that demonstrate when and how they may be applied.
Prerequisites: MATH 345, MATH 412, MATH 420.

MATH 5523 Real Variables II Credits: 3
Prerequisites: MATH 5513.
MATH 5524 Mathematics for Secondary Teachers: Geometry Credits: 3
Designed for secondary-school teachers. Examine high school mathematics from a higher point of view. Congruence, distance and similarity, trigonometry, area and volume, axioms and Euclidean geometry, analyses of alternate approaches, extensions, and applications of mathematical ideas, discussion of historical contexts and connections between ideas that may have been studied separately in different courses, relationships of ideas studied in secondary-school to those students may encounter in later study. When taken for graduate credit as Math 5524, an extra project is required.
Prerequisites: MATH 300, MATH 301.

MATH 5527 Matrix Theory II Credits: 3
Prerequisites: MATH 5517.

MATH 5532 Advanced Numerical Analysis I Credits: 3
Error Analysis, Solving Systems of Linear Equations, Solutions of Nonlinear Equations, the Least-Squares Problems, and Approximating functions. Continued in MATH 5542.
Prerequisites: MATH 402, MATH 420.

MATH 5542 Advanced Numerical Analysis II Credits: 3
Prerequisites: MATH 5532.

MATH 5545 Mathematical Methods In Science And Engineering Credits: 3
This course offers applied linear algebra and Fourier analysis which are indispensable tools in science and engineering. It is designed for beginning graduate students with moderate background in linear algebra and real analysis. Many of the results that are presented in the course will be proved rigorously from mathematical point of view.
Prerequisites: MATH 402, MATH 406, and MATH 420.

MATH 5557 Functional Analysis Credits: 3
Hilbert spaces, linear operators, compact operators, Banach spaces, the Hahn-Banach theorem, the open mapping and closed graph theorems, the principle of uniform boundedness, locally convex spaces.
Prerequisites: MATH 402 and MATH 420.

MATH 5575 Stochastic Calculus for Finance Credits: 3
This course presents the basic idea and theory of stochastic calculus with the focus on the applications to finance. Topics include Brownian motion, Itô integral, Itô formula, Black-Scholes equation and formula, risk-neutral pricing, connections with partial differential equations, exotic options, American derivative securities, and term structure models for interest rates.
Prerequisites: MATH 402 and STAT 436.

MATH 5590 Special Topics Credits: 1-3
Selected topics in various fields of mathematics. May be repeated for credit when the topic varies.

MATH 5699 Research And Thesis Credits: 1-16
Doctoral dissertation.

MATH 5899 Required Graduate Enrollment Credit: 1

Statistics Courses
STAT 115 Statistical Reasoning Credits: 3
This course is intended for majors in less quantitative fields. The focus of the course will be on developing critical thinking abilities and decision making using data in everyday life. Emphasis will be on statistical reasoning underlying the methods of sampling, statistical inference in terms of evaluating the accuracy of an estimate in the context of uncertainty, drawing conclusions from data and studying relationships in data. Students will be trained to perform hands-on-analysis of real data sets using a computer package. No previous computing experience is required.

STAT 235 Elementary Statistics Credits: 3
An introduction to descriptive and inferential statistics. Organization and presentation of data, averages and variations, elementary probability, random variables, special discrete distributions, normal distributions, sampling distributions, point estimation, confidence intervals, and hypothesis testing.
Prerequisites: MATH 110 with a grade of C- or higher, or ALEKS score of 61 or higher.

STAT 436 Introduction To Mathematical Statistics I Credits: 3
This course is the first of a calculus-based statistics sequence. It begins with basic concepts of probability, discrete and continuous distributions, expectation and variance, and ends with the central limit theorem. Recommended preparation: MATH 301 or COMP-SCI 191.
Prerequisites: MATH 220.
STAT 441 Introduction To Mathematical Statistics II Credits: 3
Sampling Distributions; point estimation; internal estimation; hypothesis testing; analysis of variance; nonparametric methods; statistical software applications; topics in Applied Statistics.
Prerequisites: STAT 436.

STAT 480 Statistical Models in Actuarial Science Credits: 3
This course covers the statistical foundation of actuarial models and their applications. Topics include survival and severity models, Kaplan-Meier and Nelson-Aalen estimators, aggregate and credibility models for insurance losses, discrete time Markov chains, ruin theory, and simulation.
Prerequisites: STAT 441.

STAT 482 Statistical Models for Life Contingencies Credits: 3
The basic statistical theory of actuarial models for life uncertainties such as time of death. Multiple life and multiple decrement models, statistical models for life and contingent insurance; last survivor, disability, withdrawal, retirement and reserving models for life insurance.
Prerequisites: STAT 441.

STAT 484 Theory of Pension and Social Security Credits: 3
Topics include policy values for policies with cash flows at discrete or continuous time intervals, multiple state models, pension mathematics such as the salary scale function, the service table, and valuation of benefits; Interest rate risk and the yield curve, emerging costs and profit testing for traditional life insurance, emerging costs for equity-linked insurance
Prerequisites: STAT 441.

STAT 496 Internship/Practical Training in Mathematics or Statistics Credits: 1-3
This course provides an internship or other practical training arrangement using mathematics or statistics in an industrial, academic or other professional setting. Department approval of internship experience or practical experience required. Repeatable with up to a combined 3 credits toward the major. Recommended preparation: MATH 250.

STAT 5501 Statistical Design Of Experiments Credits: 3
This course is designed to present a variety of experimental design techniques to students with moderate mathematical and statistical background. The course includes three major components: efficient factorial designs, linear and quadratic process optimization of the location parameter, and variability reduction. Students will be trained to use the SPSS statistical software package.
Prerequisites: STAT 436.

STAT 5537 Mathematical Statistics I Credits: 3
Prerequisites: MATH 402.

STAT 5547 Mathematical Statistics II Credits: 3
Continuation of STAT 5537.

STAT 5551 Applied Statistical Analysis Credits: 3
Methods for analyzing data from experiments and observational studies; design-based and model-based inferences; model assessment; ANOVA; power analysis; SAS procedures.
Prerequisites: STAT 441.

STAT 5561 Time Series Analysis Credits: 3
This course is intended to present the basis knowledge (including models, methods and concepts) of time series analysis to students with a good background in intermediate mathematical statistics. Some elementary knowledge of basic linear regression analysis would be helpful but not necessary. The presentation will be balanced between theory and data analysis, with sufficient theory to understand the basis of methods and a broad variety of models and many real data examples. Case studies will be drawn from business and economics, network traffic and meteorology, and data will be analyzed by students using existing computer programs (SAS, Minitab and R). Students are also expected to understand proper use and limits of time series models.
Prerequisites: STAT 441.

STAT 5565 Regression Analysis Credits: 3
Simple linear regression; multiple linear regression; correlation analysis; model selections; checking assumptions; regression diagnostics; combating multi-collinearity; nonlinear regression.
Prerequisites: STAT 441.

STAT 5572 Multivariate Analysis Credits: 3
Random vectors; multivariate normal distributions; Hotelling's T-square distribution; Wishart distribution; inferences on one mean vector; MANOVA; inferences on covariance matrices; profile analysis.
Prerequisites: MATH 420 and STAT 441.
STAT 5575 Stochastic Calculus for Finance Credits: 3
This course presents the basic idea and theory of stochastic calculus with the focus on the applications to finance. Topics include Brownian motion, Ito integral, Ito formula, Black-Scholes equation and formula, risk-neutral pricing, connections with partial differential equations, exotic options, American derivative securities, and term structure models for interest rates.
Prerequisites: MATH 402 and STAT 436.

STAT 5576 Probability Credits: 3
Existence and extension of measure, random variable, expectation and its properties, types of convergence, law of large numbers, weak convergence, central limit theorem, and martingale.
Prerequisites: STAT 436 and MATH 5513.

STAT 5578 Advanced Mathematical Statistics Credits: 3
Exponential and location families, principles of data reduction, asymptotic distributions, advanced theory of estimation and hypothesis testing.
Prerequisites: STAT 5547.

STAT 5588 Theory of Linear Model Credits: 3
This course covers vector space, full rank linear model, general inverse, estimation under linear constraints interval estimation, hypothesis testing, distributions of quadratic forms, general distribution theory, estimability, Gauss-Markov theorem, Best Linear Unbiased Estimation (BLUE), regression on dummy variables, estimation of variance components, Scheffe and Turkey intervals, and non-full rank linear model.
Prerequisites: MATH 420, STAT 5537, and STAT 5565.

STAT 5590 Special Topics Credits: 1-3
Selected topics in various fields of mathematics. May be repeated for credit when the topic varies.