MATHEMATICS AND STATISTICS

The Department of Mathematics and Statistics offers a variety of programs leading to five different degrees:

- B.A. degree: mathematics major;
- B.S. in mathematics degree;
- B.S. in applied mathematics degree;
- B.S. in mathematics education degree; and
- B.S. in statistics degree.

These programs provide flexibility through elective choices and are designed to maximize educational and employment opportunities. Each student must enroll in one specific program; however, changes between programs usually can be accommodated.

The first two years of all programs are similar. In the first year, students are expected to take MATH 425 Calculus I and MATH 426 Calculus II, as well as an introductory programming course (either MATH 445 Mathematics and Applications with MATLAB or CS 410C Introduction to Scientific Programming/C or CS 410P Introduction to Scientific Programming/Python). A sophomore typically takes follow-up calculus courses in MATH 527 Differential Equations with Linear Algebra and MATH 528 Multidimensional Calculus, MATH 539 Introduction to Statistical Analysis, and MATH 531 Mathematical Proof. The senior capstone experience is fulfilled by a variety of designated courses in each of the degree programs; specific details are given in each program's course listing below.

For more information about the department's undergraduate programs, visit http://ceps.unh.edu/mathematics-statistics

Standards for Graduation

In all courses used to satisfy the requirements for its major programs, the Department of Mathematics and Statistics requires that a student earn a grade of C- or better and have an overall grade-point average of at least 2.00 in these courses.

Minoring in Mathematics

The Department of Mathematics and Statistics offers three minor programs: mathematics, applied mathematics, and statistics. These programs, which are open to all students enrolled at the University, require a minimum of five MATH courses as detailed below. Students whose major program requires more than two courses required by the minor program must substitute additional courses from the list of elective courses to meet the five-course minimum.

https://ceps.unh.edu/mathematics-statistics

Programs

- Applied Mathematics Major (B.S.)
- Applied Mathematics Major: Computation Option (B.S.)
- Applied Mathematics Major: Economics Option (B.S.)
- Applied Mathematics Minor
- Math Education Major: Elementary/Middle School Education K-8 Option (B.S.)

- Mathematics Education Major: Secondary Education Option (B.S.)
- Mathematics Education Minor
- Mathematics Major (B.A.)
- Mathematics Major (B.S.)
- Mathematics Minor
- Statistics Major (B.S.)
- Statistics Minor

Courses

Mathematics & Statistics (MATH)

MATH 400 - Freshman Seminar
Credits: 1
A seminar experience that presents a mathematical culture associated with first-year college mathematics, including the ideas of abstraction, theorem and proof, ad that provides a perspective of the diversity of mathematical areas of research and their interrelationships. Emphasis is on reading and writing mathematics.
Grade Mode: Credit/Fail Grading

MATH 418 - Analysis and Applications of Functions
Credits: 4
Analysis and applications of algebraic and transcendental functions, with special emphasis on exponential, logarithmic, and trigonometric functions. Graphical analysis. Written projects are required on some or all of the following topics: rates of change, optimization, logarithmic or exponential modeling, and trigonometric functions. Intended for students planning to take MATH 425. Not offered for credit if credit is received for MATH 424 or MATH 425.
Grade Mode: Letter Grading

MATH 420 - Finite Mathematics
Credits: 0 or 4
Topics selected from probability, systems of linear equations, matrix algebra, linear programming, mathematics of finance. Not a preparation for calculus. Not offered for credit to mathematics majors.
Attributes: Quantitative Reasoning(Disc)
Mutual Exclusion: No credit for students who have taken MATH 422.
Grade Mode: Letter Grading

MATH 421 - Pathways between Mathematics and the Arts
Credits: 4
Exploration of the interaction between mathematics and the arts on numerous levels. The course builds on basic knowledge of elementary number systems to illuminate such topics symmetry, fractals, light, color, sound structures and musical materials. Students immediately apply new knowledge and techniques to make computer generated 2-D and 3-D images, animations and sound/music.
Attributes: Quantitative Reasoning(Disc)
Grade Mode: Letter Grading

MATH 422 - Mathematics for Business Applications
Credits: 4
Functions, sets and their use in mathematical models in business, economics and finance, including probability, linear systems and mathematics of finance; basic concepts of differential calculus and relevant applications.
Attributes: Quantitative Reasoning(Disc)
Mutual Exclusion: No credit for students who have taken MATH 420.
Grade Mode: Letter Grading
Special Fee: Yes

MATH 424A - Calculus for Social Sciences
Credits: 4

Rational, exponential and logarithmic functions; associated derivatives and their applications; associated antiderivatives and their applications. Applications focus on contexts relevant to majors in the College of Liberal Arts and the Paul College. Not offered for credit to CEPS majors. Repeat rule applies for MATH 425 and MATH 424B. Students wanting a two-semester calculus course are strongly advised to take MATH 425-426. Those students who successfully complete MATH 424A and subsequently wish to continue their study of mathematics with MATH 426 are encouraged to complete supplementary modules available from the Mathematics Center (MaC).
Attributes: Quantitative Reasoning(Disc)
Equivalent(s): MATH 424B, MATH 425
Grade Mode: Letter Grading

MATH 424B - Calculus for Life Sciences
Credits: 0 or 4

Rational, exponential and logarithmic functions; associated with derivatives and their applications; associated with antiderivatives and their applications. Applications focus on contexts relevant to majors in the College of Life Sciences and Agriculture. Not offered for credit for CEPS majors. Repeat rule applies for MATH 425 and MATH 424A. Students wanting a two-semester calculus course are strongly advised to take MATH 425-426. Those students who successfully complete MATH 424B and subsequently wish to continue their study of mathematics with MATH 426 are encouraged to complete supplementary modules available from the Mathematics Center (MaC).
Attributes: Quantitative Reasoning(Disc)
Equivalent(s): MATH 424A, MATH 425
Grade Mode: Letter Grading

MATH 425 - Calculus I
Credits: 4

Calculus of one variable covering limits, derivatives of algebraic, trigonometric, exponential, and logarithmic functions; applications include curve sketching, max-min problems, related rates, and volume and area problems. Beginning in Spring 2019 students who have taken MATH 418 may not take the placement test as a means of entry into MATH 425. (Repeat rule applies for MATH 424A and MATH 424B).
Attributes: Quantitative Reasoning(Disc)
Prerequisite(s): MATH 418 with a minimum grade of C or ALEKS Math Assessment with a score of 80.
Equivalent(s): MATH 424A, MATH 424B, MATH 425H
Mutual Exclusion: No credit for students who have taken MTH 705.
Grade Mode: Letter Grading

MATH 425H - Honors/Calculus I
Credits: 4

Calculus of one variable covering limits, derivatives of algebraic, trigonometric, exponential, and logarithmic functions; applications include curve sketching, max-min problems, related rates, and volume and area problems. (Not offered for credit if credit is received for MATH 424.)
Co-requisite: INCO 425H
Attributes: Honors course; Quantitative Reasoning(Disc)
Prerequisite(s): MATH 418 with a minimum grade of C or ALEKS Math Assessment with a score of 80.
Equivalent(s): MATH 425
Grade Mode: Letter Grading

MATH 426 - Calculus II
Credits: 4

Second course in calculus of one argument, techniques and applications of integration, polar coordinates, and series.
Prerequisite(s): MATH 425 with a minimum grade of D- or MATH 425H with a minimum grade of D-.
Equivalent(s): MATH 426H
Mutual Exclusion: No credit for students who have taken MTH 707.
Grade Mode: Letter Grading

MATH 426H - Honors/Calculus II
Credits: 4

Second course in calculus of one argument, techniques and applications of integration, polar coordinates, and series.
Co-requisite: PHYS 408H
Attributes: Honors course
Prerequisite(s): MATH 425 with a minimum grade of D- or MATH 425H with a minimum grade of D-.
Equivalent(s): MATH 426
Grade Mode: Letter Grading

MATH 439 - Statistical Discovery for Everyone
Credits: 4

Introduces the framework and concepts for learning with data. Emphasis on statistical discovery in everyday life and on drawing valid conclusion from data. Topics include: good and bad data, data ethics, how to conduct a valid survey, how to describe a population distribution; when to believe a poll; how to design an experimental study; how to avoid ambiguous results caused by "lurking" variables; how to make inference about an entire population based on a sample; how to describe relationships among variables; an understanding of the question of causation and chance in everyday life and in scientific studies, as well as the use and misuse of statistics in explaining what is statistical significance. This course has an activity-based learning component with lab exercises using statistical software for calculations without assuming a calculus background. The course may be used as a preparation for a more technical introductory statistics course. Science and Engineering students should take MATH 539 or MATH 644 according to their programs.
Attributes: Quantitative Reasoning(Disc)
Mutual Exclusion: No credit for students who have taken ADM 430, ADMN 420, ADMN 510, BIOL 528, EREC 525, HHS 540, MATH 539, MATH 644, MTH 701, PSYC 402, PSYC 402H, SOC 402, SOC 402H, SOC 502, SOC 502H.
Grade Mode: Letter Grading

MATH 444 - Excursions in Quantitative Reasoning
Credits: 4

Problems involving quantitative reasoning (most are nontraditional, some are fun, while others are interdisciplinary) designed to inspire curiosity encourages students to formulate and evaluate questions, all the while slowly drawing them into the process of scholarly investigation. In this regard, in addition to traditional mathematics homework, students need to do research outside of class to write and present projects.
Attributes: Quantitative Reasoning(Disc); Inquiry (Discovery)
Grade Mode: Letter Grading

MATH 445 - Mathematics and Applications with MATLAB
Credits: 4

Through the use of the MATLAB computation software, this course reinforces and builds on a student's mathematics foundation and previews more advanced mathematical concepts. The power and limitations of modern computational algorithms to solve real world problems are introduced and shown to influence nearly every aspect of modern society. The state-of-the-art computational tools afforded by MATLAB provide the student with a strategy for enhancing their knowledge and comprehension in subsequent Science, Engineering, or Technology themed courses.

Attributes: Environment,TechSociety(Disc)
Prerequisite(s): MATH 418 with a minimum grade of D- or MATH 424A with a minimum grade of D- or MATH 424B with a minimum grade of D- or MATH 425 with a minimum grade of D- or MATH 425H with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken IAM 550.
Grade Mode: Letter Grading

MATH 525 - Linearity I
Credits: 6

Examines the fundamental role that linear models play in science and engineering; and the role of linearization in understanding nonlinear phenomena. Models are considered along several conceptual axes: discrete to continuous, one-dimensional to multidimensional, and static to dynamic, with an emphasis on the former. Mathematical areas of coverage include matrix algebra, concepts from calculus of several variables, difference equations, and linear transformations. Lab.

Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 526 - Linearity II
Credits: 6

Continuation of study of linear models and the process of linearization begun in MATH 525, with an emphasis on models of dynamic phenomena. Additional mathematical areas of coverage include differential equations, eigenvalue and eigenvector analysis, phase plane analysis, and additional concepts from vector calculus. Lab.

Prerequisite(s): MATH 525 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 527 - Differential Equations with Linear Algebra
Credits: 0 or 4

Fundamental methods of solving first-order equations, essentials of matrix algebra; higher-order linear equations, and linear systems; series solutions; Laplace transforms; selected applications.

Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Equivalent(s): MATH 527H
Mutual Exclusion: No credit for students who have taken .
Grade Mode: Letter Grading

MATH 528 - Multidimensional Calculus
Credits: 0 or 4

Partial differentiation; composite functions and chain rules; maximum and minimum; transformations; vector algebra; vector functions; gradient, divergence, and curl; curves and surfaces; multiple, line, and surface integrals; divergence, Green's and Stoke's theorem.

Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken .
Grade Mode: Letter Grading

MATH 531 - Mathematical Proof
Credits: 4

Introduces reading and writing proofs in mathematics. The basic language of mathematics common to all branches of the subject, especially set theory and basic logic.

Attributes: Writing Intensive Course
Prerequisite(s): MATH 425 with a minimum grade of D- or MATH 425H with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 539 - Introduction to Statistical Analysis
Credits: 4

A first course introducing concepts of probability and scientific methods for data analysis. Exploratory data analysis, survey sampling, probability, discrete and continuous distributions, confidence intervals, hypothesis testing, comparing samples, linear regression, analysis of variance. Statistical software is used. Offered primarily for mathematics majors; engineering majors should take MATH 644.

Prerequisite(s): MATH 425 with a minimum grade of D- or MATH 425H with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken ADM 430, ADMN 420, ADMN 510, BIOL 528, COMP 490, EREC 525, HHS 540, MATH 439, MATH 644, PSYC 402, PSYC 402H, SOC 402, SOC 502, SOC 502H.
Grade Mode: Letter Grading

MATH 545 - Introduction to Linear Algebra
Credits: 4

Designed to reinforce ideas seen throughout the mathematics curriculum. Centered on a study of vector spaces and linear systems, beginning with a brief focus on systems of linear equations and progressing to a full discussion of linear transformation and vector spaces. The course includes a survey of properties of matrices, such as rank, kernel, eigenvalues, eigenvectors, and diagonalization.

Attributes: Writing Intensive Course
Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken MATH 645, MATH 762, MTH 709.
Grade Mode: Letter Grading

MATH 601 - Exploring Mathematics for Teachers I
Credits: 4

Provides prospective elementary teachers with the opportunity to explore and master concepts involving number systems and operations, data analysis and probability. Additional topics may include geometry, measurement, and algebraic thinking. Mathematical reasoning, problem solving, and the use of appropriate manipulatives and technology are integrated throughout the course. Readings, class discussions, and assignments focus on mathematics content as well as applicable theories of learning, curriculum resources, and state and national recommendations. The course models instructional techniques that can be adapted to the elementary curricula. (Not offered for credit if credit is received for MATH 621 or MATH #623; not offered for credit to CEPS majors.)

Grade Mode: Letter Grading

MATH 621 - Number Systems for Teachers
Credits: 4

Ways of representing numbers, relationships between numbers, number systems, the meanings of operations and how they relate to one another, and computation within the number system as a foundation for algebra; episodes in history and development of the number system; and examination of the developmental sequence and learning trajectory as children learn number concepts.
Equivalent(s): MATH 701
Mutual Exclusion: No credit for students who have taken MTH 703.
Grade Mode: Letter Grading

MATH 622 - Geometry for Teachers
Credits: 4

Explorations of the foundations of informal measurement and geometry in one, two and three dimensions. The van Hiele model for geometric learning is used as a framework for how children build their understanding of length, area, volume, angles and geometric relationships. Visualization, spatial reasoning and geometric modeling are stressed. As appropriate, transformational geometry, congruence, similarity and geometric constructions will be discussed.
Mutual Exclusion: No credit for students who have taken MTH 704.
Grade Mode: Letter Grading

MATH #623 - Probability and Statistics for Teachers
Credits: 4

An introduction to probability, descriptive statistics and data analysis; exploration of randomness, data representation and modeling. Descriptive statistics will include measures of central tendency, dispersion, distributions and regression. Analysis of experiments requiring hypothesizing, experimental design and data gathering.
Mutual Exclusion: No credit for students who have taken MTH 701.
Grade Mode: Letter Grading

MATH 624 - Analysis of Secondary School Mathematics
Credits: 4

Examines concepts from calculus and pre-calculus mathematics with an emphasis on connecting and logically refining the concepts of function, limit, sequences, series, and probability. Includes a deeper analysis of problems and topics drawn from secondary school mathematics with the kind of mathematical knowledge and sophistication that the student has gained from other collegiate mathematics courses. Proofs for many of the theorems that are typically introduced in a non-rigorous fashion in calculus are studied. Offered in alternate years in the spring semester following MATH #623.
Prerequisite(s): EDUC 500 with a minimum grade of D- and MATH 425 with a minimum grade of D- and MATH 545 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 632 - Financial Mathematics
Credits: 4

A mathematical introduction to interest theory and an overview of mathematical models used to analyze and price standard financial instruments including: interest bearing accounts, stocks and bonds. Introduction to basic concepts used in mathematical finance including: random variables, mathematics of arbitrage, risk and diversification. Includes a substantive introduction to all aspects of the financial mathematics actuarial exam.
Grade Mode: Letter Grading

MATH 644 - Statistics for Engineers and Scientists
Credits: 4

Introduces the design of controlled experiments and the collection and analysis of scientific data. Use of a statistical software package is an integral part of the course; interpreting and drawing conclusions from standard software output is emphasized. Graphical data analysis, statistical process control, regression and correlation, multifactor experimental designs, confidence intervals, hypothesis testing.
Prerequisite(s): MATH 426 (may be taken concurrently) with a minimum grade of D- or MATH 426H (may be taken concurrently) with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken ADM 430, ADMN 420, ADMN 510, BIOL 528, COMP 490, EREC 525, HHS 540, MATH 439, MATH 539, PSYC 402, PSYC 402H, SOC 402, SOC 402H, SOC 502, SOC 502H.
Grade Mode: Letter Grading

MATH 645 - Linear Algebra for Applications
Credits: 4

Fundamental notions of vector space theory, linear independence, basis, span, scalar product, orthogonal bases. Includes a survey of matrix algebra, solution of systems linear equations, rank, kernel, eigenvalues and eigenvectors, the LU- and QR-factorizations, and least squares approximation. Selected applications in mathematics, science, engineering and business.
Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken MATH 545, MATH 762.
Grade Mode: Letter Grading

MATH 647 - Complex Analysis for Applications
Credits: 4

Complex numbers, analytic functions, Cauchy-Riemann equations, conformal mapping, contour integration, Cauchy's integral formula, infinite series, residue calculus, Fourier and Laplace transforms. (Not offered for credit if credit is received for MATH 788.)
Prerequisite(s): MATH 528 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken MATH 788.
Grade Mode: Letter Grading

MATH 696 - Independent Study
Credits: 1-4

Individual projects of study developed by the student and a faculty sponsor. Intended for students with superior scholastic achievement. May be taken as writing intensive. A written proposal, including goals and assessment, endorsed by a faculty sponsor and approved by the department chairperson, must be submitted before registering.
Repeat Rule: May be repeated for a maximum of 8 credits.
Equivalent(s): MATH 696W
Grade Mode: Letter Grading

MATH 696W - Independent Study
Credits: 1-4

Individual projects of study developed by the student and a faculty sponsor. Intended for students with superior scholastic achievement. A written proposal, including goals and assessment, endorsed by a faculty sponsor and approved by the department chairperson, must be submitted before registering.
Attributes: Writing Intensive Course
Repeat Rule: May be repeated for a maximum of 8 credits.
Equivalent(s): MATH 696
Grade Mode: Letter Grading

MATH 700 - Introduction to Mathematics Education
Credits: 4

General background information about mathematics education, such as theories of learning and teaching mathematics, mathematics curricula, classroom management, and techniques for the teaching and learning of mathematics that are common to all levels of mathematics education K-12.
Prerequisite(s): MATH 426 with a minimum grade of D- and EDUC 500 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken EDC 731.
Grade Mode: Letter Grading

MATH 703 - Teaching of Mathematics in Grades K-5
Credits: 4

Methods of teaching mathematics at the elementary school level; uses of technology, manipulatives, models, and diagrams; developing unit and lesson plans; assessment ; instructional formats; teaching reading and writing in mathematics.
Prerequisite(s): MATH 621 with a minimum grade of D- or MATH 601 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken EDC 724, EDC 733.
Grade Mode: Letter Grading

MATH 709 - Teaching of Mathematics in Grades 6-12
Credits: 4

Methods of teaching mathematics at the middle and high school levels; uses of technology, manipulatives, models, and diagrams; developing unit and lesson plans; assessment; instructional formats; teaching reading and writing in mathematics.
Prerequisite(s): MATH 700 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken EDC 733, EDC 734.
Grade Mode: Letter Grading

MATH 732 - Introduction to the R Software
Credits: 1

This course provides a basic introduction to the open-sources statistical software R for students who have never used this software or have never formally learned the basics of it. Topics include: Numeric calculations, simple and advanced graphics, object management and work-flow, RStudio, user-contributed packages, basic programming, writing of functions, statistical modeling and related graphs, distributed computing, reproducible research and document production via markup language.
Equivalent(s): MATH 759
Grade Mode: Credit/Fail Grading

MATH 734 - Statistical Computing
Credits: 4

This is a course on statistics-oriented programming and common computational methodologies used in statistics. Students will learn principles and techniques of sample-splitting, cross-validation, simulation, bootstrap, and optimization, and how to implement them in R. The students will gain experience of reading/modifying, writing and debugging code, and how to speed up computation.
Prerequisite(s): MATH 738 with a minimum grade of D- or MATH 739 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 736 - Advanced Statistical Modeling
Credits: 4

This is a course on statistical models behind normal linear model. Topics covered in this course include generalized linear model, linear mixed model, generalized additive model, generalized linear mixed model, generalized additive mixed model, and smoothing methods if time allows.
Prerequisite(s): MATH 739 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 737 - Statistical Methods for Quality Improvement and Design
Credits: 4

Six Sigma is a popular, data-focused methodology used worldwide by organizations to achieve continuous improvement of their existing processes, products and services or to design new ones. This course provides a thorough introduction to the Six Sigma principles, methods, and applications for continuous improvement (DMAIC process) and an overview of Design for Six Sigma (DFSS). Both manufacturing and non-manufacturing (transactional Six Sigma) applications are included. Emphasis is placed on the use of case studies to motivate the use of, as well as the proper application of, the Six Sigma methodology. Formal Six Sigma Green Belt certification from UNH may be attained by successfully completing TECH 696.
Prerequisite(s): MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 738 - Data Mining and Predictive Analytics
Credits: 4

An introduction to supervised and unsupervised methods for exploring large data sets and developing predictive models. Unsupervised methods include: market basket analysis, principal components, clustering, and variables clustering. Important statistical and machine learning methods (supervised learning) include: Classification and Regression Trees (CART), Random Forests, Neural Nets, Support Vector Machines, Logistics Regression and Penalized Regression. Additional topics focus on metamodeling, validation strategies, bagging and boosting to improve prediction or classification, and ensemble prediction from a set of diverse models. Required case studies and projects provide students with experience in applying these techniques and strategies. The course necessarily involves the use of statistical software and programming languages. Undergraduate students are required to have junior or senior status to in enroll in this course.
Prerequisite(s): MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken .
Grade Mode: Letter Grading

MATH 739 - Applied Regression Analysis
Credits: 4

Statistical methods for the analysis of relationships between response and input variables: simple linear regression, multiple regression analysis, residual analysis and model selection, multi-collinearity, nonlinear curve fitting, categorical predictors, analysis of variance, analysis of covariance, examination of validity of underlying assumptions, logistic regression analysis. Emphasizes real applications with use of statistical software.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 740 - Design of Experiments I
Credits: 4
Course in design of experiments with applications to quality improvement in industrial manufacturing, engineering research and development, or research in physical and biological sciences. Experimental factor identification, statistical analysis and modeling of experimental results, randomization and blocking, full factorial designs, random and mixed effects models, replication and sub-sampling strategies, fractional factorial designs, response surface methods, mixture designs, and screening designs. Focuses on various treatment structures for designed experimentation and the associated statistical analyses. Use of statistical software.
Prerequisite(s): MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH #741 - Survival Analysis
Credits: 4
Explorations of models and data-analytic methods used in medical, biological, and reliability studies. Event-time data, censored data, reliability models and methods, Kaplan-Meier estimator, proportional hazards, Poisson models, loglinear models. The use of statistical software, such as SAS, JMP, or R, is fully integrated into the course. (Offered in alternate years in the spring semester.)
Prerequisite(s): MATH 739 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 743 - Time Series Analysis
Credits: 4
An introduction to univariate time series models and associated methods of data analysis and inference in the time domain and frequency domain. Topics include: auto regressive (AR), moving average (MA), ARMA and ARIMA processes, stationary and non-stationary processes, seasonal ARIMA processes, auto-correlation and partial auto-correlation functions, identification of models, estimation of parameters, diagnostic checking of fitted models, forecasting, spectral density function, periodogram and discrete Fournier transform, linear filters, parametric spectral estimation, dynamic Fournier analysis. Additional topics may include wavelets and long memory processes (FARIMA) and GARCH Models. The use of statistical software, such as JMP, or R, is fully integrated into the course. Offered in alternate years in the spring semester.
Prerequisite(s): MATH 739 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH #744 - Design of Experiments II
Credits: 4
A second course in design of experiments, with applications in quality improvement and industrial manufacturing, engineering research and development, research in physical and biological sciences. Covers experimental design strategies and issues that are often encountered in practice: complete and incomplete blocking, partially balanced incomplete blocking (PBIB), partial confounding, intra and inter block information, split plotting and strip plotting, repeated measures, crossover designs, Latin squares and rectangles, Youden squares, crossed and nested treatment structures, variance components, mixed effects models, analysis of covariance, optimizations, space filling designs, and modern screening design strategies.
Prerequisite(s): MATH 740 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 745 - Foundations of Applied Mathematics I
Credits: 4
An introduction to Partial Differential Equations (PDEs) and associated mathematical methods and the analytical foundation for applied mathematics. Topics include: PDE classification, superposition, separation of variables, orthonormal functions, completeness, convergence, Fourier Series, Sturm-Liouville eigenvalue problems, and eigenfunctions. Methods are introduced for the analysis and solution of boundary value problems, in particular, the Heat, Wave, and Laplace equations.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 528 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH #746 - Foundations of Applied Mathematics II
Credits: 4
An introduction to special functions, asymptotic analysis, and transform methods applied to partial differential equations. Topics include: Boundary value problems in cylindrical coordinates, the Bessel equation and Bessel functions, Fourier-Bessel expansions in cylindrically symmetric spatial domains, the Fourier Transform, the Hilbert Transform, Cosine and Sine Transforms, problems on semi-infinite intervals, and Asymptotic Analysis.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 528 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 747 - Introduction to Nonlinear Dynamics and Chaos
Credits: 4
The mathematics of chaos and nonlinear dynamics. Topics include linear and nonlinear systems of ordinary differential equations, discrete maps, chaos, phase plane analysis, bifurcations and computer simulations.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 528 with a minimum grade of D- and MATH 645 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 753 - Introduction to Numerical Methods I
Credits: 4
Introduces mathematical algorithms and methods of approximation. Topics include a wide survey of approximation methods. Methods examined include polynomial interpolation, root finding, numerical linear algebra, numerical integration, and the approximation of differential equations. Included in each case is a study of the accuracy and stability of a given technique, as well as its efficiency.
Prerequisite(s): MATH 426 with a minimum grade of D- and (MATH 445 with a minimum grade of D- or CS 410C with a minimum grade of D- or CS 410P with a minimum grade of D- or IAM 550 with a minimum grade of D-).
Grade Mode: Letter Grading

MATH 755 - Probability with Applications
Credits: 4
Introduces the theory, methods, and applications of randomness and random processes. Probability concepts, random variable, expectation, discrete and continuous probability distributions, joint distributions, conditional distributions; moment-generating functions, convergence of random variables.
Prerequisite(s): MATH 528 with a minimum grade of D- and (MATH 539 with a minimum grade of D- or MATH 644 with a minimum grade of D-).
Grade Mode: Letter Grading

MATH 756 - Principles of Statistical Inference
Credits: 4
Introduces the basic principles and methods of statistical estimation and model fitting. One- and two-sample procedures, consistency and efficiency, likelihood methods, confidence regions, significance testing, Bayesian inference, nonparametric and re-sampling methods, decision theory.
Prerequisite(s): MATH 755 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 757 - Mathematical Optimization for Applications
Credits: 4
This course introduces the foundations of mathematical optimization and reinforces them via applications. The content includes convex optimization, first and second-order methods, constrained problems, duality, linear and quadratic programming, as well as discrete and non-convex optimization. Applications will focus on machine learning methods but also include problems from engineering and operations research. Programming proficiency in MATLAB, R, Java, C, Python, or equivalent is required prior to taking this course.
Prerequisite(s): MATH 426 with a minimum grade of D- or MATH 426H with a minimum grade of D-.
Equivalent(s): CS 757
Grade Mode: Letter Grading

MATH 760 - Geometry
Credits: 4
Advanced approach to fundamental properties of Euclidean and other geometries through deductive reasoning and proof.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 761 - Abstract Algebra
Credits: 4
This course establishes the axiomatic framework that underlies number systems and similar mathematical structures, investigating basic properties of groups, rings, fields and their homomorphisms.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 763 - Abstract Algebra II
Credits: 4
This course extends the investigations of MATH 761 into more specialized situations related to old and new problems in mathematics, such as the nature of solutions of polynomial equations. It presents advanced properties of groups, rings, fields and their applications.
Prerequisite(s): MATH 761 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 765 - Introduction to Commutative Algebra and Algebraic Geometry
Credits: 4
Methods of determining solution sets of polynomial systems; affine varieties and their ideals; the 'algebra-geometry correspondence'; theory and applications of Grobner bases.
Prerequisite(s): MATH 761 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 767 - One-Dimensional Real Analysis
Credits: 4
Theory of limits, continuity, differentiability, and integrability.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 768 - Real Analysis II
Credits: 4
Theory of integration; series; power series and uniform convergence of power series.
Prerequisite(s): MATH 767 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 769 - Introduction to Differential Geometry
Credits: 4
Introduction to the study of geometric properties of curves and surfaces in 3-dimensional space.
Prerequisite(s): MATH 527 with a minimum grade of D- and MATH 528 with a minimum grade of D- and MATH 645 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 770 - Foundations of Number Theory
Credits: 4
Factorization and prime numbers, arithmetic functions, congruences, reciprocity laws, quadratic forms, Diophantine equations, computational number theory. Offered in alternate years.
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 772 - Combinatorics
Credits: 4
Graph theory (including planar graphs, graph coloring, Hamiltonian circuits, trees); counting principles (including permutations, combinations, pigeonhole principle, inclusion-exclusion principle); and related topics.
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH #776 - Logic
Credits: 4
Examination of the basic notions of soundness and completeness, first for sentential and then for propositional logic. Turning to the question of decision procedures for logical formulae, the concept of recursive function, which emerges in the work of Church and Turning, provides the essential link between logic and theory of computation. The course culminates with Godel's Incompleteness Theorems, which demonstrate the intrinsic limitations of the logical method. Offered in alternate years.
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 783 - Set Theory
Credits: 4
Axiomatic set theory, including its history. Cantor's theory of infinite cardinal and ordinal numbers seemed laden with contradictions and paradoxes. A satisfactory treatment of these difficulties came with the axiomatic set theory of Zermelo and Fraenkel. This course develops the Zermelo-Fraenkel axioms and examines cardinal and ordinal arithmetic in the context they provide. The course then investigates the consequences of various additional axioms extending Zermelo-Fraenkel, such as the Axiom of Choice, the Continuum Hypothesis, large cardinal axioms of determinacy. Offered in alternate years.
Prerequisite(s): MATH 531 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 784 - Topology
Credits: 4
Open sets, closure, base, and continuous functions; connectedness, compactness, separation axioms, and metrizability.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 767 with a minimum grade of D-.
Grade Mode: Letter Grading

MATH 788 - Complex Analysis
Credits: 4
Complex functions, sequences, limits, differentiation and Cauchy-Riemann equations, elementary functions, Cauchy's theorem and formula, Taylor's and Laurent's series, residues, conformal mapping. Not offered for credit if credit is received for MATH 647.
Prerequisite(s): MATH 767 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken MATH 647.
Grade Mode: Letter Grading

MATH 790 - Historical Foundations of Mathematics
Credits: 4
Historical development of number theory, geometry, probability, algebra, and analysis. Study of the significant mathematical contributions to these topics made by prominent mathematicians spanning several historical periods.
Attributes: Writing Intensive Course
Prerequisite(s): MATH 531 with a minimum grade of D- or MATH 545 with a minimum grade of D-.
Mutual Exclusion: No credit for students who have taken MTH 706.
Grade Mode: Letter Grading

MATH 796 - Topics
Credits: 1-4
New or specialized courses not covered in regular course offerings.
Repeat Rule: May be repeated up to unlimited times.
Grade Mode: Letter Grading

MATH 797 - Senior Seminar
Credits: 4
Exploration of mathematical topics beyond the student's previous coursework in the seminar format. The course focus is on independent research, collaborative work and classroom engagement; oral presentations and written work are required.
Grade Mode: Letter Grading

MATH 798 - Senior Project
Credits: 4
Students work either individually or as a group under the direction of a faculty sponsor to plan and carry out an independent research project resulting in a written report and presentation to the department. Students must submit a written proposal approved by a faculty sponsor and by the department chairperson before registering.
Grade Mode: Letter Grading

MATH 799 - Senior Thesis
Credits: 2 or 4
Students work under the direction of a faculty sponsor to plan and carry out independent research resulting in a written thesis. Required for honors-in-major. Students must submit a written proposal approved by a faculty sponsor and by the department chairperson before registering.
Attributes: Writing Intensive Course
Repeat Rule: May be repeated for a maximum of 4 credits.
Grade Mode: Letter Grading

Faculty

Mathematics and Statistics Department Faculty