MATHEMATICS

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Majors in Mathematics - B.S.

Specific Requirements for Admission to the Mathematics Major

Students desiring to major in mathematics should apply to the department and be assigned a major advisor after completing MTH 245 Calculus I or MTH 246 Calculus II or its equivalent.

- Major in Data Science (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/data-science-bs/)
- Major in Mathematics (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/mathematics-bs/)
- Major in Mathematics: Medical Mathematics Track (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/mathematics-medical-mathematics-bsmth/)
- Major in Mathematics: Secondary Education Track (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/mathematics-secondary-education-bs/)

Minors in Mathematics

- Data Science minor (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/data-science-minor/)
- Mathematics minor (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/mathematics-minor/)

Students who think they may teach Mathematics must consult with the Education Department, with the Mathematics Department, and with the appropriate agency in the state in which they intend to teach.

Associate of Science degree (A.S.)

This department offers the following associate degree:

- Mathematics, A.S. (http://catalog.creighton.edu/undergraduate/arts-sciences/as-mathematics/)

Certificate Program

- Mathematics (http://catalog.creighton.edu/undergraduate/arts-sciences/mathematics/mathematics-cert/)

Courses

MTH 103. Intermediate Algebra. 3 credits. FA, SP, SU
Topics from second-year algebra to form an introduction to college algebra.

MTH 105. Math for Elementary Teachers. 4 credits.
Typical elementary school topics will be reviewed and extended to related topics of exponential notation, significant figures, measures of change, economic principles and the normal distribution. In so doing, all applicable NCTM Standards will be covered.

MTH 125. Practical Math. 3 credits.
To present common situations requiring quantitative analysis or calculations, to prepare the student to think logically through these situations, to model them mathematically, and to reach an accurate conclusion. Two years of high school algebra is expected. This course is repeatable to a max of 9 credits.

MTH 131. Earth Algebra. 3 credits. FA, OD
College Algebra material; environmental issues; functions; atmospheric carbon dioxide concentration; composite functions and inverses; global temperature and ocean level; quadratic functions; systems of linear equations and matrices; carbon dioxide emission. P. Four semesters of high school algebra.

MTH 139. Precalculus. 3 credits. FA, SP
This course will cover the basic concepts that are required for further study of mathematics including a course in calculus. The course topics include solving linear, quadratic, exponential and logarithmic equations; linear and quadratic inequalities; properties and graphs of polynomial, rational, exponential, logarithmic, trigonometric and inverse trigonometric functions; angles; right triangles; trigonometric identities and equations.

MTH 141. Applied Calculus. 3 credits. FA, SP, SU
Main topic is differential and integral calculus and applications. Includes sections on partial derivatives. P. Heider College of Business students only.

MTH 161. Business Statistics. 3 credits.
An introduction to descriptive and inferential statistics for business. Topics include measures of central tendency and dispersion, sampling and estimation, confidence intervals, regression and correlation, and relevant examples from business, finance and economics. This course for HCOB students and Economics majors and minors in CCAS only.

MTH 201. Applied Mathematics. 3 credits. FA, SP, SU
Foundations of quantitative reasoning, applications of systems of equations, optimization techniques, probability, and statistics. P. Heider College of Business students only.

MTH 205. Mathematics for the Modern World. 2 credits.
Foundations course in mathematics for those not needing calculus. Topics include basic number theory, graphs, estimation, data analysis and curve fitting, probability and analysis of risk, and fairness in voting systems.

MTH 206. Mathematical Reasoning and Statistics. 3 credits.
This is a 3-credit online course for students not needing calculus. We will be considering basic number theory, graphs, estimation, data analysis, probability, statistics, and analysis of risk. You will become familiar with these topics and demonstrate mastery via weekly homework, discussion posts, and quizzes, two written projects, and one cumulative exam.

MTH 231. Calculus for the Biological Sciences. 3 credits.
Differential and integral calculus and a brief introduction to differential equations, with applications to the biological sciences. NOTE: Not intended for CHM, MTH and PHY majors.

MTH 245. Calculus I. 4 credits. FA, SP, SU
Differential and integral calculus of algebraic and transcendental functions.

MTH 246. Calculus II. 4 credits. FA, SP, SU
Techniques of integration, infinite series, and other topics. P. MTH 245 or equivalent.

MTH 249. Modeling the Physical World I. 3 credits.
First semester in the sequence on mathematical modeling using calculus. Course is taught jointly with PHY 221. Topics include elementary differential equations, techniques of integration, sequences and series, vector analysis, and applications. This course is equivalent to MTH 246. P. MTH 245 or permission of the instructor. CO: PHY 221.

MTH 260. Introduction to Statistics. 3 credits.

MTH 310. Introduction to Abstract Mathematics. 3 credits. FA, SP
A systematic study of the basic concepts in mathematics, including set theory; logic; proof techniques, basic properties of integers; relations; functions; congruences; introduction to groups; sequences and series, and basic properties of a topological space. P. MTH 246 or MTH 249 or equivalent.

MTH 321. Euclidean and Non-Euclidean Geometry. 3 credits.
Basic geometric concepts and applications. P. MTH 246 or MTH 249.

MTH 347. Calculus III. 3 credits. FA, SP
This course covers vector algebra and calculus in two- and three-dimensional space. P. MTH 246 or MTH 249 or equivalent.

MTH 349. Modeling the Physical World II. 3 credits.
Second semester in the sequence on mathematical modeling using calculus. Course is taught jointly with PHY 222. Topics include multivariable functions and calculus, series integration (Green's, Stokes', and Divergence theorems) and applications. P. MTH 249 and PHY 221. CO: PHY 222.

MTH 350. Applied Linear Algebra and Differential Equations. 3 credits.
This course is a survey of the techniques to solve elementary differential equation and linear algebra problems. Topics include solving linear systems, eigenvalues, eigenvectors, exact equations, integrating factors, and constant coefficient systems of ODE. The class is computational in nature and is suitable for students in the applied sciences. P. MTH 246 or MTH 249 or equivalent.

MTH 355. Essentials of Epidemiology. 3 credits. (Same as HAP 355, STA 355)
This course introduces the concepts and includes exercises related to epidemiology, the discipline that serves as the basic science of public health, or population health, by providing evidence for defining the public health problem, assessing causation, and evaluating effectiveness of potential interventions.

MTH 360. Elementary Probability and Statistics. 3 credits.
Non-calculus approach with emphasis on measures of central tendency and variability, distributions and testing of hypothesis. Designed for students in natural and social sciences, or business. Meets requirements for Designated Statistical Reasoning and Designated Technology. Prereq: Mathematical Reasoning course.

MTH 361. Probability and Statistics in the Health Sciences. 3 credits.
This course covers topics in probability and statistics considered useful to those students planning on a career in the health sciences. The topics covered include probability principles and distributions in health sciences, types of epidemiologic study designs, estimation of medical parameters in defined patient populations, test of hypothesis, measures and analysis of treatment of the sick, analysis of variance, methods of medical outcome prediction, and prospective, retrospective and cross-sectional studies of disease occurrence. This course meets Designated Statistical Reasoning and Designated Technology requirements. Prereq: Mathematical Reasoning course.

MTH 362. Statistical Modeling. 3 credits.
Inferential statistical methods, ANOVA, design and analysis of experiments, regression and nonparametric methods. P. MTH 360 or MTH 361 or instructor consent.

MTH 365. Introduction to Data Science. 3 credits.
Intro to statistical data science, using computing tools to gather, manage and analyze large and complex data sets. Topics include data wrangling and formatting, web scraping, data analysis, statistical modeling techniques, text mining and language processing. P. Mathematical Reasoning; CSC 121/221 or significant programming experience with instructor consent.

MTH 366. Machine Learning. 3 credits.
Introduction to machine and statistical learning techniques. Topics include supervised learning (regression models, kernel smoothers), unsupervised learning (clustering or principal component analysis), shrinkage models, additive models, and neural networks. P. MTH 360 or MTH 361 or another introductory stat course with Instructor Consent; MTH 365.

MTH 400. Current Issues in Mathematics. 1 credit.
MTH 400 is a capstone course where students make oral presentations of current mathematics topics. Students will be guided through picking a topic, finding materials, writing up a presentation, and making a presentation. The students will offer constructive criticism of each other's presentations. P. Ethics course, Oral Communication course, MTH 310, and one of the following: MTH 347, MTH 349 or MTH 350; Junior or Senior standing.

MTH 411. Combinatorics. 3 credits.
Basic counting methods, generating functions, spanning trees, recurrence relations, network algorithms and the inclusion-exclusion formula, applications to information processing and retrieval. P. MTH 310 or Instructor Consent.

MTH 429. Advanced Linear Algebra. 3 credits.
Vector spaces and subspaces; linear transformations; matrices, eigenvalues and eigenvectors. P. MTH 350.

MTH 431. Mathematical History, Philosophy And Ethics. 3 credits. OD (Same as HIS 431, SRP 431)
An examination of mathematics and mathematical ideas and their relation to philosophical and ethical views from the ancient Babylonians and Pythagoreans to the present. Special attention will be given to non-Western mathematics, ethnomathematics, twentieth-century game theory, encryption, and ethical issues facing the mathematician and society in the past and today. The course assumes no mathematical background beyond the Core E requirements. P. Sr. stdg; PHL 250 or THL 250.

MTH 443. Numerical Analysis. 3 credits.
Numerical differentiation and integration; solutions of equations and systems of equations; polynomial approximation; error analysis and eigenvectors; applications to digital computers. P. MTH 246 or MTH 249.

MTH 445. Advanced Differential Equations. 3 credits.
Systems of differential equations, qualitative, theory, Laplace and Fourier transforms, partial differential equations, series solutions, Fourier series. P. MTH 350.

MTH 446. Partial Differential Equations. 3 credits.
Integral curves and surfaces of vector fields; the Cauchy-Kovalesky theorem; general linear PDEs, their characteristics and classification; solutions to, and applications of, linear and quasi-linear first order and second order PDEs; Laplace's equation, the heat equation and the wave equation. P. MTH 445.

MTH 447. Mathematics in Medicine and the Life Sciences I. 3 credits.
This course is intended to be an overview of a variety of mathematical topics considered useful to those students intending to pursue a career in medicine or the life sciences. The topics covered include mathematics of populations, infectious diseases, and excitable cells. P. MTH 246 or MTH 249 and a Magis Core Ethics course.

MTH 448. Mathematics in Medicine and Life Sciences II. 3 credits.
This course continues the investigation of math modeling in biomedical sciences. Biological topics include excitable cells, the cardiovascular system, tumors, and the immune system, metabolic systems, and chemotaxis; mathematical techniques include ordinary, stochastic, and partial differential equations. P. MTH 350, MTH 447 or Instructor consent.

MTH 451. Differential Geometry. 3 credits.
Calculus of curves, surfaces and manifolds; topics will include hyperbolic geometry, vectors and tensors, fundamental forms, curvature, covariant derivatives, with applications to special and general relativity. P. MTH 347 or MTH 349.

MTH 455. Chaotic Dynamical Systems. 3 credits.
This course will study discrete dynamical systems. Topics covered will include one-dimensional and higher-dimensional dynamical systems, fixed points, stability theory, linearization, phase spaces, bifurcation theory, index theory, limit cycles and periodicity, chaos, and attractors. Applications to Biology, Physics, Chemistry, and other areas will be studied. P. MTH 350; MTH 347 or MTH 349.

MTH 457. Graph Theory. 3 credits.
Basic properties of graphs, subgraphs, simple graphs, walks, paths, circuits, cycles, connectivity, Eulerian and Hamiltonian graphs, adjacency and incidence matrices, trees, spanning trees, planar graphs, graph coloring, networks. P. MTH 310.

MTH 459. Topology. 3 credits.
Set theory; metric space; topological spaces; connectedness; compactness; selected related topics. P. MTH 246 or MTH 249.

MTH 467. Operations Research. 3 credits.
Introductory course in operations research. Linear models and solutions using the simplex method, duality theory and sensitivity analysis. P. MTH 350.

MTH 471. Mathematical Analysis. 3 credits.
Properties of Euclidean spaces and their applications to functions. P. MTH 310 and Contemporary Composition course.

MTH 472. Mathematical Analysis II. 3 credits.
Continuation of MTH 471; functions in metric space. P. MTH 471.

MTH 473. Complex Analysis. 3 credits.
Complex arithmetic, polar representations, functions of a complex variable, analyticity and the Cauchy-Riemann equations, complex integration, Cauchy Integral Formula, series, poles and residues, applications to real integration, conformal mappings. P. MTH 347 or MTH 349.

MTH 481. Modern Algebra I. 3 credits.
Groups, rings; fields; applications to coding theory. P. MTH 310.

MTH 482. Modern Algebra II. 3 credits.
Rings; ideals; field extensions; Galois theory; applications to coding theory. P. MTH 481.

MTH 493. Directed Independent Readings. 1-3 credits. FA, SP
May be repeated to a limit of six hours. P. DC.

MTH 495. Directed Independent Study. 1-3 credits. FA, SP
May be repeated to a limit of six hours. P. DC.

MTH 497. Directed Independent Research. 1-3 credits. FA, SP
May be repeated to a limit of six hours. P. DC.

MTH 509. Discrete Structures. 3 credits.
Logic; Boolean algebra; switching circuits; graphs; groups; semi-groups; finite state machines; coding theory; grammars; algorithms. P. CSC 221; 6 hrs. college MTH.

MTH 525. Automata, Computability, and Formal Languages. 3 credits. OD
Finite state concepts; acceptors; formal grammars; computability; Turing machines. P. MTH 246 or MTH 249.

MTH 541. Mathematics for Data Scientists. 3 credits.
Matrix algebra, vector spaces, bases, linear transformations, linear operators and their properties, introduction to the fundamental principles of mathematical models, especially those useful in data science. P. MTH 246 or equivalent with a grade of B or better.

MTH 561. Mathematical Statistics I. 3 credits. FA, SU (Same as STA 561)
Introduction to probability and probability distributions including techniques for finding expected values and variance of discrete and continuous variables. These distributions and their properties are examined to establish their application to applied statistical methods. P. MTH 246 or MTH 249.

MTH 562. Mathematical Statistics II. 3 credits. SP (Same as STA 562)
Using probability distributions as a foundation and random sampling, methods for estimating distribution parameters are developed with applications to hypothesis testing. The course also includes an introduction to linear models, regression analysis, analysis of variance and design of experiments. P. MTH 561.

MTH 563. Mathematical Statistics III. 3 credits. OD (Same as STA 563)
Optimal decision procedures, further normal distribution theory, noncentral chi-square and F distributions, introduction to the theoretical basis for analysis of variance, nonparametric methods. P. MTH 562.

MTH 573. Probabilistic Models. 3 credits. OD
Queuing theory, inventory theory, Markov processes, simulation and nonlinear programming. P. MTH 561.

MTH 575. Introductory Stochastic Processes. 3 credits. OD
Random walk, normal processes and covariance stationary processes, counting processes and Poisson processes, renewal counting processes, discrete and continuous parameter Markov chains. P. MTH 561.

MTH 599. Seminar. 1-3 credits. OD
Topics in advanced mathematics selected by the instructor. P. IC.

STA 355. Essentials of Epidemiology. 3 credits. (Same as HAP 355, MTH 355)
This course introduces the concepts and includes exercises related to epidemiology, the discipline that serves as the basic science of public health, or population health, by providing evidence for defining the public health problem, assessing causation, and evaluating effectiveness of potential interventions.

STA 361. Probability and Statistics in the Health Sciences. 3 credits.
This course covers topics in probability and statistics considered useful to those students planning on a career in the health sciences. The topics covered include probability principles and distributions in health sciences, types of epidemiologic study designs, estimation of medical parameters in defined patient populations, test of hypothesis, measures and analysis of treatment of the sick, analysis of variance, methods of medical outcome prediction, and prospective, retrospective and cross-sectional studies of disease occurrence. Prereq: Mathematical Reasoning course; MTH 141, MTH 201, MTH 205, MTH 245 or MTH 249.

STA 493. Directed Independent Readings. 1-3 credits.
May be repeated to a limit of six hours.

STA 495. Directed Independent Study. 1-3 credits.
May be repeated to a limit of six hours.

STA 497. Directed Independent Research. 1-6 credits.
May be repeated to a limit of six hours.

STA 499. Senior Thesis: Supervised Consulting. 1-3 credits.
May be repeated to a limit of six hours. P. DC.

STA 521. Computational Methods In Statistics. 3 credits. OD
Use of packages of statistical programs, calculation of statistical tables. Monte Carlo methods. P. A course in statistics; CSC 221.

STA 525. Nonparametric Methods. 3 credits. OD
Applications of nonparametric estimates, confidence, intervals, tests, and multiple comparison procedures. P. A course in statistics.

STA 527. Sample Surveys. 3 credits. OD
Simple, systematic, stratified, and cluster random sampling; proportions; ratios; selection of sample size. P. A course in statistics.

STA 561. Mathematical Statistics I. 3 credits. FA (Same as MTH 561)
Introduction to probability and probability distributions including techniques for finding expected values and variance of discrete and continuous variables. These distributions and their properties are examined to establish their application to applied statistical methods. P. MTH 246 or MTH 249.

STA 562. Mathematical Statistics II. 3 credits. SP (Same as MTH 562)
Using probability distributions as a foundation and random sampling, methods for estimating distribution parameters are developed with applications to hypothesis testing. The course also includes an introduction to linear models, regression analysis, analysis of variance and design of experiments. P. STA 561.

STA 563. Mathematical Statistics III. 3 credits. OD (Same as MTH 563)
Optimal decision procedures, further normal distribution theory, noncentral chi-square and F distributions, introduction to the theoretical basis for analysis of variance, nonparametric methods. P. STA 562.

STA 567. Linear Statistical Models. 3 credits. OD
Least squares method; general linear hypothesis; multiple correlation and regression; analysis of covariance. P. STA 561; MTH 350.

STA 569. Analysis Of Variance And Design Of Experiments. 3 credits. OD
One- and two-way classifications; blocking; nesting; multiple comparisons; incomplete designs; variance components; factorial experiments; confounding. P. STA 561.

STA 571. Operations Research. 3 credits. OD (Same as MTH 571)
Introductory course in operations research. Linear models and solutions using the simplex method, duality theory and sensitivity analysis. P. MTH 350.

STA 573. Probabilistic Models. 3 credits. OD
Queuing theory, inventory theory, Markov processes, simulation, and nonlinear programming. P. STA 561.

STA 575. Introductory Stochastic Processes. 3 credits. OD
Random walk, normal processes and covariance stationary processes, counting processes and Poisson processes, renewal counting processes, discrete and continuous parameter Markov chains. P. STA 561.

STA 577. Applied Multivariate Analysis. 3 credits. OD
Inference about mean vectors and covariance matrices, canonical correlation, principal components, discriminant analysis, cluster analysis, computer techniques. P. STA 563, STA 567.

STA 579. Applied Time Series Analysis. 3 credits. OD
Forecasting; Box-Jenkins models; time series; regression; exponential smoothing; transfer function models; auto covariance functions. P. STA 561.