

MATHEMATICS (MATH)

MATH 1050 (a, MCSR) Quantitative Reasoning

Eric Gaze.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

Explores the ways and means by which we communicate with numbers; the everyday math we encounter on a regular basis. The fundamental quantitative skill set is covered in depth providing a firm foundation for further coursework in mathematics and the sciences. Topics include ratios, rates, percentages, units, descriptive statistics, linear and exponential modeling, correlation, logic, and probability. A project-based course using Microsoft Excel, emphasizing conceptual understanding and application. Reading of current newspaper articles and exercises involving personal finance are incorporated to place the mathematics in real-world context.

Prerequisites: Placement in MATH 1050 (S/M) or Placement in MATH 1050 or 1051 (S/M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 1300 (a, MCSR) Biostatistics

Erin Carmody.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

An introduction to the statistical methods used in the life sciences. Emphasizes conceptual understanding and includes topics from exploratory data analysis, the planning and design of experiments, probability, and statistical inference. One and two sample t-procedures and their non-parametric analogs, one-way ANOVA, simple linear regression, goodness of fit tests, and the chi-square test for independence are discussed. An average of four to five hours of class meetings and computer laboratory sessions per week. Not open to students who have credit for Economics 2557, Psychology 2520, or Mathematics 1200 or have credit or are concurrently enrolled in Mathematics 1400.

Prerequisites: MATH 1050 or MATH 1051 or Placement in MATH 1300 or 1400 (S) or Placement in MATH 1300 (S) or Placement in MATH 1300 or 2206(S).

Previous terms offered: Spring 2023, Fall 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 1400 (a, MCSR) Statistics in the Sciences

Jack O'Brien.

Every Spring. Fall 2023. Enrollment limit: 30.

Formatted in consideration of the use of statistics as a means for principled argumentation in the natural and social sciences, and examines historical, computational, mathematical, and practical examples. Readings from the scientific literature are paired with techniques to interpret data in a variety of contexts. Explorations of the interconnections between statistics, mathematics, scientific practice, and computation underlie all aspects. Topics include: probability, Bayesian reasoning, random variables, standard statistical tests, such as t-tests, regression, and ANOVA, p-values, hypothesis testing, computation, data visualization, and scientific writing. Not open to students who have credit for Economics 2557, Psychology 2520, Mathematics 1200, or have credit or are concurrently enrolled in Mathematics 1300.

Prerequisites: MATH 1600 or MATH 1700 or MATH 1750 or MATH 1800 or Placement in MATH 1400 (S) or Placement in MATH 1300 or 1400 (S) or Placement in MATH 1400 or 2206 (S).

Previous terms offered: Spring 2023, Spring 2022, Spring 2020.

MATH 1600 (a, MCSR) Differential Calculus

Ehssan Khanmohammadi.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

Functions, including the trigonometric, exponential, and logarithmic functions; the derivative and the rules for differentiation; the anti-derivative; applications of the derivative and the anti-derivative. Four to five hours of class meetings and computer laboratory sessions per week, on average. Open to students who have taken at least three years of mathematics in secondary school.

Prerequisites: MATH 1050 or Placement in MATH 1600 (M) or PHYS 1093 (same as CHEM 1093) or MATH 1051.

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 1610 (a) Emerging Scholars Differential Calculus Workshop

Eric Gaze.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 08. .5 Credit Credit/D/F Only.

Supplemental problem-solving workshop for differential calculus students. Concurrent enrollment in Math 1600 required. Enrollment by permission of instructor. One-half credit. Grading is Credit/D/Fail.

Prerequisites: MATH 1050 or Placement in MATH 1600 (M) or PHYS 1093 (same as CHEM 1093).

Previous terms offered: Spring 2023, Fall 2022.

MATH 1700 (a, MCSR) Integral Calculus

Leah Sturman; Ehssan Khanmohammadi.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

The definite integral; the Fundamental theorems; improper integrals; applications of the definite integral; differential equations; and approximations including Taylor polynomials and Fourier series. An average of four to five hours of class meetings and computer laboratory sessions per week.

Prerequisites: MATH 1600 or Placement in MATH 1700 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 1710 (a) Emerging Scholars Integral Calculus Workshop

Eric Gaze.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 08. .5 Credit Credit/D/F Only.

Supplemental problem-solving workshop for integral calculus students. Concurrent enrollment in Math 1700 required. Enrollment by permission of instructor. One-half credit. Grading is Credit/D/Fail.

Prerequisites: MATH 1600 or Placement in MATH 1700 (M).

Previous terms offered: Spring 2023, Fall 2022.

MATH 1750 (a, MCSR) Intermediate Integral Calculus

Erin Carmody.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

A review of the exponential and logarithmic functions, techniques of integration, and numerical integration. Improper integrals. Approximations using Taylor polynomials and infinite series. Emphasis on differential equation models and their solutions. An average of four to five hours of class meetings and computer laboratory sessions per week. Open to students whose backgrounds include the equivalent of Mathematics 1600 and the first half of Mathematics 1700. Designed for first-year students who have completed an AB Advanced Placement calculus course in their secondary schools.

Prerequisites: Placement in MATH 1750 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2020, Fall 2019.

MATH 1800 (a, MCSR) Multivariate Calculus

Adam Levy; Mary Lou Zeeman.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

Multivariate calculus in two and three dimensions. Vectors and curves in two and three dimensions; partial and directional derivatives; the gradient; the chain rule in higher dimensions; double and triple integration; polar, cylindrical, and spherical coordinates; line integration; conservative vector fields; and Green's theorem. An average of four to five hours of class meetings and computer laboratory sessions per week.

Prerequisites: MATH 1700 or MATH 1750 or Placement in MATH 1800 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 1808 (a, MCSR) Biomathematics

Every Fall. Enrollment limit: 30.

A study of mathematical modeling in biology, with a focus on translating back and forth between biological questions and their mathematical representation. Biological questions are drawn from a broad range of topics, including disease, ecology, genetics, population dynamics, and neurobiology. Mathematical methods include discrete and continuous (ODE) models and simulation, box models, linearization, stability analysis, attractors, oscillations, limiting behavior, feedback, and multiple time-scales. Within the biology major, this course may count as the mathematics credit or as biology credit, but not both. Students are expected to have taken a year of high school or college biology prior to this course. (Same as: BIOL 1174)

Prerequisites: MATH 1600 or higher or Placement in MATH 1700 (M) or Placement in MATH 1750 (M) or Placement in MATH 1800 (M) or Placement in 2000, 2020, 2206 (M) or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2023, Spring 2022, Fall 2020, Fall 2019.

MATH 2000 (a, MCSR) Linear Algebra

Benjamin Levy; Leah Sturman; Naomi Tanabe.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

A study of linear algebra in the context of Euclidean spaces and their subspaces, with selected examples drawn from more general vector spaces. Topics will include: vectors, linear independence and span, linear transformations, matrices and their inverses, bases, dimension and rank, determinants, eigenvalues and eigenvectors, diagonalization and change of basis, and orthogonality. Applications drawn from linear systems of equations, discrete dynamical systems, Markov chains, computer graphics, and least-squares approximation.

Prerequisites: MATH 1800 or Placement in 2000, 2020, 2206 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 2020 (a, MCSR) Introduction to Mathematical Reasoning

Jennifer Taback; Chandrika Sadanand.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 20.

An introduction to logical deductive reasoning and mathematical proof through diverse topics in higher mathematics. Specific topics include set and function theory, modular arithmetic, proof by induction, and the cardinality of infinite sets. May also consider additional topics such as graph theory, number theory, and finite state automata.

Prerequisites: MATH 1800 or Placement in 2000, 2020, 2206 (M) or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 2109 (a, MCSR) Optimization

Every Other Spring. Enrollment limit: 30.

A study of optimization problems arising in a variety of situations in the social and natural sciences. Analytic and numerical methods are used to study problems in mathematical programming, including linear models, but with an emphasis on modern nonlinear models. Issues of duality and sensitivity to data perturbations are covered, and there are extensive applications to real-world problems.

Prerequisites: MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2021, Fall 2020, Fall 2019.

MATH 2206 (a, MCSR) Probability

Leah Sturman.

Every Semester. Fall 2023. Enrollment limit: 35.

A study of the mathematical models used to formalize nondeterministic or “chance” phenomena. General topics include combinatorial models, probability spaces, conditional probability, discrete and continuous random variables, independence and expected values. Specific probability densities, such as the binomial, Poisson, exponential, and normal, are discussed in depth.

Prerequisites: MATH 1800 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 2208 (a, MCSR) Ordinary Differential Equations

Benjamin Levy.

Every Semester. Fall 2023; Spring 2024. Enrollment limit: 30.

A study of some of the ordinary differential equations that model a variety of systems in the physical, natural and social sciences. Classical methods for solving differential equations with an emphasis on modern, qualitative techniques for studying the behavior of solutions to differential equations. Applications to the analysis of a broad set of topics, including population dynamics, oscillators and economic markets. Computer software is used as an important tool, but no prior programming background is assumed.

Prerequisites: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M).

Previous terms offered: Spring 2023, Fall 2022, Spring 2022, Fall 2021, Spring 2021, Fall 2020, Spring 2020, Fall 2019.

MATH 2209 (a, MCSR) Numerical Methods

Adam Levy.

Every Other Spring. Spring 2024. Enrollment limit: 30.

An introduction to the theory and application of numerical analysis. Topics include approximation theory, numerical integration and differentiation, iterative methods for solving equations, and numerical analysis of differential equations.

Prerequisites: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M).

Previous terms offered: Spring 2022, Spring 2020.

MATH 2301 (a, MCSR) Intermediate Linear Algebra

Every Other Spring. Enrollment limit: 35.

A continuation of Linear Algebra focused on the interplay of algebra and geometry as well as mathematical theory and its applications. Topics include matrix decompositions, eigenvalues and spectral theory, vector and Hilbert spaces, norms and low-rank approximations. Applications to biology, computer science, economics, and statistics, including artificial learning and pattern recognition, principal component analysis, and stochastic systems. Course and laboratory work balanced between theory and application.

Prerequisites: Two of: MATH 2000 or Placement in MATH 2020 or 2206 (M) and MATH 2020.

Previous terms offered: Fall 2022, Spring 2020.

MATH 2303 (a, MCSR) Functions of a Complex Variable

Naomi Tanabe.

Every Other Fall. Spring 2024. Enrollment limit: 35.

The differential and integral calculus of functions of a complex variable. Cauchy's theorem and Cauchy's integral formula, power series, singularities, Taylor's theorem, Laurent's theorem, the residue calculus, harmonic functions, and conformal mapping.

Prerequisites: MATH 1800 or Placement in 2000, 2020, 2206 (M) or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2022, Fall 2019.

MATH 2404 (a, MCSR) Geometry

Chandrika Sadanand.

Every Other Spring. Spring 2024. Enrollment limit: 30.

A survey of modern approaches to Euclidean geometry in two dimensions. Axiomatic foundations of metric geometry. Transformational geometry: isometries and similarities. Klein's Erlanger Program. Symmetric figures. Other topics may be chosen from three-dimensional geometry, ornamental groups, area, volume, fractional dimension, and fractals.

Prerequisites: MATH 2020.

Previous terms offered: Spring 2023, Spring 2022, Fall 2020, Fall 2019.

MATH 2502 (a, MCSR) Number Theory and Cryptography

Jennifer Taback.

Every Other Spring. Fall 2023. Enrollment limit: 30.

A survey of number theory from Euclid's proof that there are infinitely many primes through Wiles's proof of Fermat's Last Theorem in 1994. Prime numbers, unique prime factorization, and results on counting primes. The structure of modular number systems. Continued fractions and “best” approximations to irrational numbers. Investigation of the Gaussian integers and other generalizations. Squares, sums of squares, and the law of quadratic reciprocity. Applications to modern methods of cryptography, including public key cryptography and RSA encryption.

Prerequisites: MATH 2020.

Previous terms offered: Spring 2021.

MATH 2601 (a, MCSR) Combinatorics and Graph Theory

Every Other Year. Enrollment limit: 35.

An introduction to combinatorics and graph theory. Topics to be covered may include enumeration, matching theory, generating functions, partially ordered sets, Latin squares, designs, and graph algorithms.

Prerequisites: Two of: MATH 2020 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2023, Fall 2021, Spring 2020.

MATH 2602 (a, MCSR) Group Theory

Every Other Fall. Enrollment limit: 35.

An introduction to the theory of finite and infinite groups, with examples ranging from symmetry groups to groups of polynomials and matrices. Properties of mappings that preserve algebraic structures are studied. Topics include cyclic groups, homomorphisms and isomorphisms, normal subgroups, factor groups, the structure of finite abelian groups, and Sylow theorems.

Prerequisites: Two of: MATH 2000 or Placement in MATH 2020 or 2206 (M) and MATH 2020.

Previous terms offered: Fall 2022, Fall 2021, Fall 2019.

MATH 2603 (a, MCSR) Introduction to Analysis

Ehssan Khanmohammadi.

Every Fall. Spring 2024. Enrollment limit: 35.

Building on the theoretical underpinnings of calculus, develops the rudiments of mathematical analysis. Concepts such as limits and convergence from calculus are made rigorous and extended to other contexts, such as spaces of functions. Specific topics include metric spaces, point-set topology, sequences and series, continuity, differentiability, the theory of Riemann integration, and functional approximation and convergence.

Prerequisites: Two of: MATH 2020 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Fall 2022, Fall 2021, Spring 2021, Fall 2019.

MATH 2606 (a, MCSR) Statistics

Jack O'Brien.

Every Spring. Spring 2024. Enrollment limit: 35.

An introduction to the fundamentals of mathematical statistics. General topics include likelihood methods, point and interval estimation, and tests of significance. Applications include inference about binomial, Poisson, and exponential models, frequency data, and analysis of normal measurements.

Prerequisites: MATH 2206.

Previous terms offered: Spring 2023, Spring 2022, Spring 2021, Spring 2020.

MATH 2702 (a, MCSR) Rings and Fields

Naomi Tanabe.

Every Other Fall. Fall 2023. Enrollment limit: 35.

An introduction to algebraic structures based on the study of rings and fields. Structure of groups, rings, and fields, with an emphasis on examples. Fundamental topics include: homomorphisms, ideals, quotient rings, integral domains, polynomial rings, field extensions. Further topics may include unique factorization domains, rings of fractions, finite fields, vector spaces over arbitrary fields, and modules. Mathematics 2502 is helpful but not required.

Prerequisites: Two of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020.

Previous terms offered: Fall 2020.

MATH 2805 (a, MCSR) Mathematical principles of machine learning

Every Other Spring. Enrollment limit: 30.

An introduction to the mathematical theory and practice of machine learning. Supervised and unsupervised learning problems, including regression, classification, clustering, and component analysis, focusing on techniques most relevant to the study and applications of neural networks. Additional topics may include dimension reduction, data visualization, denoising, norms and loss functions, optimization, universal approximation theorems, and algorithmic fairness. Class will include computer lab and projects, but no formal programming experience is necessary.

Prerequisites: MATH 2603.

Previous terms offered: Spring 2023, Spring 2022.

MATH 3108 (a) Advanced Topics in Modeling

Mary Lou Zeeman.

Every Other Spring. Spring 2024. Enrollment limit: 16.

A study of mathematical modeling, with emphasis on how to identify scientific questions appropriate for modeling, how to develop a model appropriate for a given scientific question, and how to interpret model predictions. Applications drawn from the natural, physical, environmental, and sustainability sciences. Model analysis uses a combination of computer simulation and theoretical methods and focuses on predictive capacity of a model.

Prerequisites: Three of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020 and MATH 2208.

Previous terms offered: Spring 2022, Fall 2019.

MATH 3109 (a) Optimal Control

Adam Levy.

Every Other Fall. Fall 2023. Enrollment limit: 16.

A study of infinite-dimensional optimization, including calculus of variations and optimal control. Classical, analytic techniques are covered, as well as numerical methods for solving optimal control problems. Applications in many topic areas, including economics, biology, and robotics.

Prerequisites: Three of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020 and MATH 2208.

Previous terms offered: Fall 2021.

MATH 3204 (a) Topology

Every Other Fall. Enrollment limit: 16.

A mathematical study of shape. Examination of surfaces, knots, and manifolds with or without boundary. Topics drawn from point-set topology, algebraic topology, knot theory, and computational topology, with possible applications to differential equations, graph theory, topological data analysis, and the sciences.

Prerequisites: Three of: MATH 2000 or Placement in MATH 2020 or 2206 (M) and MATH 2020 and either MATH 2602 or MATH 2603 or MATH 2702.

Previous terms offered: Fall 2022, Spring 2021.

MATH 3208 (a) Advanced Topics in Dynamical Systems

Every Other Spring. Enrollment limit: 16.

A study of nonlinear dynamical systems arising in applications, with emphasis on modern geometric, topological, and analytical techniques to determine global system behavior, from which predictions can be made. Topics chosen from local stability theory and invariant manifolds, limit cycles and oscillation, global phase portraits, bifurcation and resilience, multiple time scales, and chaos. Theoretical methods supported by simulations. Applications drawn from across the sciences.

Prerequisites: Four of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020 and MATH 2208 and MATH 2603.

Previous terms offered: Fall 2022, Spring 2020.

MATH 3209 (a) Partial Differential Equations

Every Other Fall. Enrollment limit: 16.

A study of some of the partial differential equations that model a variety of systems in the natural and social sciences. Classical methods for solving partial differential equations are covered, as well as modern, numerical techniques for approximating solutions. Applications to the analysis of a broad set of topics, including air quality, traffic flow, and imaging. Computer software is used as an important tool.

Prerequisites: Three of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020 and MATH 2208.

Previous terms offered: Spring 2023, Spring 2021, Fall 2020.

MATH 3303 (a, MCSR) Advanced Complex Analysis

Every Other Spring. Enrollment limit: 16.

A second course in complex analysis. Topics may include conformal mappings, harmonic functions, and analytic functions. Applications drawn from boundary value problems, elliptic functions, two-dimensional potential theory, Fourier analysis, and topics in analytic number theory.

Prerequisites: Three of: MATH 2020 and MATH 2303 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Fall 2022, Spring 2020.

MATH 3404 (a) Advanced Topics in Geometry

Chandrika Sadanand.

Every Other Fall. Fall 2023. Enrollment limit: 16.

An introduction to advanced topics in geometry, including Euclidean and non Euclidean geometries in two dimensions, unified by the transformational viewpoint of Klein's Erlangen Program. Additional topics will vary by instructor and may include isometry groups of Euclidean and hyperbolic spaces, alternate models of hyperbolic geometry, differential geometry and projective geometry. Math 2404, or any higher numbered course, is helpful but not required.

Prerequisites: Three of: MATH 2000 or Placement in MATH 2020 or 2206 (M) or Placement in 2000, 2020, 2206 (M) and MATH 2020 and either MATH 2301 or MATH 2404 or MATH 2502 or MATH 2601 or MATH 2602 or MATH 2603 or MATH 2702.

Previous terms offered: Fall 2021, Fall 2020.

MATH 3602 (a) Advanced Topics in Group Theory

Every Other Spring. Enrollment limit: 16.

The study of group actions on geometric objects; understanding finite and discrete groups via generators and presentations. Applications to geometry, topology, and linear algebra, focusing on certain families of groups. Topics may include Cayley graphs, the word problem, growth of groups, and group representations.

Prerequisites: Three of: MATH 2602 and MATH 2020 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2023, Spring 2022.

MATH 3603 (a) Advanced Analysis

Every Other Spring. Enrollment limit: 16.

Measure theory and integration with applications to probability and mathematical finance. Topics include Lebesgue measure and integral, measurable functions and random variables, convergence theorems, analysis of random processes including random walks and Brownian motion, and the Ito integral.

Prerequisites: Three of: MATH 2020 and MATH 2603 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2022, Spring 2020.

MATH 3606 (a) Advanced Topics in Probability and Statistics

Jack O'Brien.

Every Other Fall. Fall 2023; Spring 2024. Enrollment limit: 16.

One or more specialized topics in probability and statistics. Possible topics include regression analysis, nonparametric statistics, logistic regression, and other linear and nonlinear approaches to modeling data. Emphasis is on the mathematical derivation of the statistical procedures and on the application of the statistical theory to real-life problems.

Prerequisites: Three of: MATH 2020 and MATH 2606 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Fall 2021, Fall 2019.

MATH 3702 (a) Advanced Topics in Rings and Number Theory

Naomi Tanabe.

Every Other Spring. Spring 2024. Enrollment limit: 16.

Advanced topics in modern algebra based on rings and fields.

Possible topics include: Galois theory with applications to geometric constructions and (in)solvability of polynomial equations; algebraic number theory and number fields such as the p-adic number system; commutative algebra; algebraic geometry and solutions to systems of polynomial equations.

Prerequisites: Three of: MATH 2020 and MATH 2702 and MATH 2000 or Placement in MATH 2020 or 2206 (M).

Previous terms offered: Spring 2021.