

MATHEMATICS (MATH)

MATH 10000 Mathematics Fundamentals (LA)

Basic concepts underlying algebra, functions, exponents, areas, fractions, and percents. Reasoning skills required for these concepts. Word problems. Meets three hours. See also MATH 18000; credit cannot be earned for both MATH 10000 and MATH 18000. Prerequisites: Math placement in group 4. (F-S,Y)

Attributes: UND

1 Credit

MATH 10400 Finite Mathematics with Calculus (LA)

Introduction to differential calculus, mathematics of finance, and linear programming. Additional topics at the instructor's discretion. Intended for students in the School of Business. Students may not receive credit for both MATH 10400 and MATH 10500, 10600, or 10700. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (F-S,Y)

Attributes: NS

4 Credits

MATH 10500 Mathematics for Decision Making (LA)

Introduction to probability theory, mathematics of finance and linear programming. Additional topics at the instructor's discretion. Students may not receive credit for both MATH 10500 and MATH 10600. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (F-S,Y)

Attributes: QL

3 Credits

MATH 10600 Mathematics for Decision Making with Technology (LA)

Introduction to probability theory; mathematics of finance; linear programming. Additional topics at the instructor's discretion. Appropriate technology is introduced to present some of the topics differently and in more depth than MATH 10500. Students may not receive credit for both MATH 10500 and MATH 10600. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (F-S,Y)

Attributes: 2B, NS

4 Credits

MATH 10800 Applied Calculus (LA)

Introduction to calculus, with an emphasis placed on problems in the business, economics, social sciences and life sciences. Topics include polynomial, exponential, and logarithmic functions and their derivatives; curve sketching, optimization, and rates of change; the definite integral and area. Further topics may be chosen from applications of differential equations and trigonometric functions. Not open to students who have taken MATH 11100. Completion of this course with a grade of C- or better will move students in group 3 to group 2. Students with group 1 placement who plan to take more than one semester of calculus should instead take MATH 11100. Prerequisites: Math placement in group 1, 2 or 3, or completion of MATH 10000 with a grade of C- or better. (F,S,Y)

Attributes: QL

4 Credits

MATH 11000 College Algebra and Trigonometry (LA)

A modeling approach to college algebra and trigonometry. Topics include algebraic expressions (including radicals and exponents); equations and inequalities; polynomial and rational functions; exponential and logarithmic functions; systems of equations; trigonometric functions and properties. Prerequisites: Math Placement 2 or 3 or completion of MATH 10000 or MATH 18000 with a grade of C- or better.. (F-S,Y)

Attributes: 2B, NS

4 Credits

MATH 11100 Calculus I (LA)

Calculus of functions of one variable. Topics include limits, continuity, derivatives, applications of derivatives (problems of motion, graphing, and optimization), antiderivatives, and an introduction to the definite integral. Functions covered include polynomial, rational, exponential, logarithmic, trigonometric, and piecewise-defined functions. Prerequisites: Math placement in group 1, or completion of MATH 11000 with a grade of C- or better. (F-S,Y)

Attributes: 2B, NS

4 Credits

MATH 11200 Calculus II (LA)

Continuation of calculus of functions of one variable. Topics include differential equations, including slope fields, numerical solutions, and separation of variables; evaluation of integrals and antiderivatives; applications of integration; improper integrals; series, with an emphasis placed on power series. Prerequisites: MATH 11100 with a grade of C- or better or MATH 10800 with a grade of B or better. (F,S,Y)

Attributes: ESTS, NS

4 Credits

MATH 13500 Mathematical Art with Computers (LA)

Focuses on mathematical concepts such as symmetry, crystallographic groups, recursive patterns, spirals, and the golden ratio as they relate to geometric design. The use of computers enables students to explore these topics without an extensive math background. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (S,Y)

Attributes: 2B, NS

3 Credits

MATH 14400 Statistics for Business, Economics and Management (LA)

A first course in statistics covering descriptive statistical techniques; introduction to probability; statistical inference including problems of estimation and hypothesis testing; correlation and regression analysis; and multiple regression. Data sets and exercises will be chosen from the fields of business, economics, and management. Technology used in this course may include graphing calculators and statistical software. Prerequisite: Math placement in group 1 or 2, or completion of MATH 10400, MATH 10800 or MATH 11000 with a grade of C- or better. Not open to students who have completed MATH 14500 or MATH 21600. (F,S,Y)

Attributes: 2B, ESTS, NS, QL

4 Credits

MATH 14500 Statistics for the Health, Life, and Social Sciences (LA)

A first course in statistics covering descriptive statistical techniques; introduction to probability; statistical inference including problems of estimation and hypothesis testing; one-way ANOVA; and design of experiments. Most of the data sets and exercises will be chosen from the fields of biology, health, and life sciences, as well as from everyday life. Technology used in this course may include graphing calculators and statistical software. Prerequisite: Math placement group 1 or 2, or completion of MATH 10400, MATH 10800 or MATH 11000 with a grade of C- or better. Not open to students who have completed MATH 14400 or MATH 21600. (F,S,Y)

Attributes: 2B, ESTS, NS, QL

4 Credits

MATH 15200 Selected Topics: What Is Mathematics? (LA)

Cultural approach to selected topics in mathematics. See instructor for current list of topics. Students may not receive credit for both MATH 15200 and MATH 25200. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (F-S,Y)

Attributes: 2B, NS

3 Credits

MATH 15300 Mathematics as a Cultural Institution (LA)

Students reflect on and find their own answer to the questions: "What is Mathematics and where does it come from?" Investigates the nature of the institution of mathematics by experiencing, reading about, and discussing several aspects of mathematical thinking and learning. Uses ideas from philosophy, psychology, history, sociology, and biology to explore and gain insight into math as it has developed historically, as it is taught in schools, and as it is used in society. Prerequisites: MATH placement in group 1, 2, or 3, or completion of MATH 10000 with a grade of C- or better. (S,Y)

Attributes: NS, SO, SS, TIII, TWOS

3 Credits

MATH 15500 Basic Statistical Reasoning (LA)

Basic concepts involved in statistical reasoning, such as sampling and experimental design, description of data, normal approximation to data, correlation and regression, and probability. Emphasis is placed on understanding the use of statistics rather than on how to do statistical analysis. Not open to students who have taken MATH 14400, MATH 14500, MATH 21600 or PSYC 20700. Prerequisites: Math placement in group 1, 2, or 3, or completion of MATH 10000 or MATH 18000 with a grade of C- or better. (F-S,Y)

Attributes: 2B, ESTS, NS, QL

3 Credits

MATH 16100 Math and Society (LA)

Explores connections between mathematics and the liberal arts. Covers three to six topics chosen for their mathematical and societal component, with comparable emphasis given to each component. Only a high school math background is assumed, but students must have scored in group 2 or 1 on the math placement exam. Actual course content varies with instructor, but examples of topics are exponential growth and world population; symmetry and group theory in art and architecture; fair allocation and equity; binomial models and the death penalty; quantitative communication and the media. Prerequisites: Math placement in group 1 or 2, or completion of MATH 11000 with a grade of C- or better. (F-S,Y)

Attributes: 2B, NS, SO, TIII, TWOS

3 Credits

MATH 16200 Proofiness (LA)

Explores the ways in which numerical arguments are used to deceive people. Discussions focus on particular types of numbers and numerical arguments in various contexts, such as education, finance, and health care. (Y)

Attributes: NS, QL

3 Credits

MATH 16300 Numbers in Education (LA)

Introduces different quantitative methods that are used by different stakeholders (teachers, administrators, and policy makers) to make decisions related to education. Topics include the achievement gap in education and data-driven instruction. (Y)

Attributes: NS, QL

3 Credits

MATH 16400 Math, Fairness, and Democracy (LA)

Addresses mathematical topics that have close connections to politics: apportionment, voting and weighted voting, fair division, and districting. (Y)

Attributes: QL, SO, TPJ, TWOS

3 Credits

MATH 18500 Math Experimentation (LA)

Students explore mathematical phenomena experimentally, detect patterns, and provide mathematical explanations for these patterns. Students gain insight into mathematical thinking and the process of conjecture by designing and implementing mathematical algorithms with a Computer Algebra System. Discrete dynamical systems including Markov chains will be investigated. Other topics vary but may include the distribution of prime numbers, modular arithmetic, the Collatz Conjecture. Prerequisites: Math placement in group 1, or completion of MATH 11000 with a grade of C- or better. (F,S,Y)

Attributes: NS

3 Credits

MATH 19000 Selected Topics in Mathematics (LA)

Topics to be determined by instructor and department. May be repeated for credit for selected topics on different subjects. Prerequisites:

Appropriate to topics. (IRR)

Attributes: 2B, NS

1-4 Credits

MATH 19100 World of Mathematics (LA)

Introduction to advanced mathematics through faculty presentations and problem-solving activities. Prerequisites: MATH 11200 or MATH 18500 (either may be taken concurrently). Pass/Fail only. (S,Y)

1 Credit

MATH 19200 Independent Study: Math (LA)

Individual study of selected subjects extending the student's mathematical knowledge. Prerequisites: Permission of instructor. (IRR)

Attributes: UND

1-3 Credits

MATH 21100 Calculus III (LA)

Introduction to vectors and the geometry of vector spaces. Calculus of functions of several variables: partial derivatives, gradients, optimization, double integrals. Prerequisites: MATH 11200 with a grade of C- or better. (F-S,Y)

Attributes: 2B, NS

4 Credits

MATH 21200 Calculus IV (LA)

Multiple integrals and change of variables. Line and surface integrals. Classical theorems of vector calculus. Prerequisites: MATH 21100 with a grade of C- or better. (S,Y)

Attributes: NS

3 Credits

MATH 21400 Differential Equations (LA)

Topics will include modeling with differential equations, existence and uniqueness of solutions, separation of variables; first order linear equations; second order equations with constant coefficients; homogeneous equations, phase plane analysis, eigenvalues; and systems of differential equations. Additional topics may include: series solutions of differential equations, non-linearity and equilibrium analysis, and transforms among others. Prerequisites: MATH 11200 with a grade of C- or better. (S,Y)

Attributes: NS

3 Credits

MATH 21600 Statistical Analysis (LA)

An introduction to statistical analysis for students with a calculus background, developing an understanding of descriptive and inferential statistics through the use of a variety of traditional and simulation methods. Topics will include hypothesis testing and parameter estimation. Additional topics to be selected from experimental design and data collection, exploratory data analysis, non-parametric methods, monte carlo and resampling methods, analysis of variance, correlation and regression. Statistical literacy and data analysis concepts will be emphasized. Prerequisites: MATH 10800 with a grade of B or better, or MATH 11100 with a grade of C- or better. (F,Y)

Attributes: NS, QL

3 Credits

MATH 22000 Mathematics for Childhood Education (LA)

This is a math content course for future elementary school teachers. Students develop a deep understanding of mathematical content, strengthen their mathematical reasoning and problem-solving skills, and learn how to help elementary students make mathematical sense of their world. (S,Y)

Attributes: NS, QL

3 Credits

MATH 23100 Linear Algebra (LA)

Topics include systems of linear equations and solutions; matrix operations; linear independence, span, basis, dimension, rank; linear operators and matrix representations; vector spaces, subspaces, change of coordinates; eigenvalues, eigenvectors; and applications.

Prerequisites: MATH 11200 with a grade of C- or better. (F,S,Y)

Attributes: NS

3 Credits

MATH 24600 Intermediate Statistics (LA)

Covers statistical methods not typically covered in introductory statistics courses. Topics include multivariate analysis and nonparametric techniques, bootstrapping and jackknife methods, and two-way ANOVA. Emphasis will be placed on working with data sets from a broad variety of disciplines with an exploratory data analysis approach. The statistical software environment R will be used in analyzing data. Prerequisite: MATH 14400, MATH 14500, MATH 21600, or PSYC 20700 with a grade of C- or better. (S,Y)

Attributes: NS, QL

3 Credits

MATH 25000 Problem-Solving Seminar (LA)

Techniques used in the solution of diverse mathematical problems are developed and discussed. Problems will often be drawn from national competitions, such as the Putnam exam and the COMAP Modeling Competition, or from problem sections of mathematics journals. The course will be offered for either 0.5 or one credit ; it may be repeated for credit up to a total of four credits. Prerequisites: MATH 11100 with a grade of C- or better. Pass/fail only. (F,S)

Attributes: NS

0.5-1 Credits

MATH 27000 Mathematical Reasoning with Discrete Mathematics (LA)

Focus is on the underpinnings of and strategies for mathematical arguments that constitute mathematical proof. These underpinnings include logical connectives, (universal and existential) quantification, and rules of deductive inference. Strategies include direct proof, indirect proof, 'proof' by counterexample, proof by cases, and proof by induction. Students learn to employ these strategies and concepts to create basic mathematical proofs. Content topics include, but are not limited to, fundamentals concepts of sets and functions as well as multiple topics from discrete mathematics that include elementary counting principles. Prerequisites: MATH 23100 or MATH 18500 with a grade of C- or better. MATH 18500 may be taken concurrently. (S,Y)

Attributes: NS

3 Credits

MATH 29000 Selected Topics in Mathematics (LA)

Topics to be determined by instructor and department. This course may be repeated for credit when topics vary. Prerequisites: Permission of instructor. (IRR)

Attributes: NS

1-4 Credits

MATH 29200 Independent Study: Math (LA)

Individual study of selected subjects extending the student's mathematical knowledge. Prerequisites: Permission of instructor. (IRR)

Attributes: UND

1-3 Credits

MATH 30300 Abstract Algebra (LA)

Introduction to algebraic structures. Study includes concepts from group theory, ring theory, or field theory. Topics may include Abelian groups, cyclic groups, permutation groups, factor groups, ideals, quotient rings, integral domains, isomorphisms, and homomorphisms. Additional topics may be included. Prerequisites: One three or four credit level 2 MATH course with a grade of C- or better. (F,Y)

Attributes: NS

4 Credits

MATH 30500 Introduction to Analysis (LA)

Topology of the real line. Continuity, differentiability, and integrability of functions of a real variable. Prerequisites: One three to four credit level 2 MATH course with a grade of C- or better. (S,Y)

Attributes: NS

4 Credits

MATH 31100 Complex Analysis (LA)

Students explore the theory of functions defined in the complex plane, highlighting the interplay between geometric visualization and analysis. Topics may include the geometry of analytic mappings, power series, Cauchy's Theorem, and the Residue Theorem. Connections to other areas of mathematics and to other scientific fields will be explored through applications. Prerequisites: MATH 21100 or MATH 23100. (E,S)

3 Credits

MATH 31600 Probability (LA)

Topics include probability systems; random variables, their distributions, and expected values. Additional topics may include queueing theory, the theory of Poisson processes and the theory of Markov processes.

Prerequisites: MATH 21100 with a grade of C- or better. (S,Y)

Attributes: NS

3 Credits

MATH 32100 Graph Theory and Combinatorics (LA)

Topics in graph theory include basic properties of graphs, Eulerian trails, Hamilton chains, trees, and may include the chromatic polynomial, planar graphs, and the independence number. Topics in combinatorics include the pigeonhole principle, permutations and combinations, the binomial theorem, and may include generating functions, Catalan numbers, and Stirling numbers. Prerequisites: COMP 22000 or one MATH course at the 200-level. (E,F)

3 Credits

MATH 33100 Numerical Analysis (LA)

Theory and applications of numerical techniques. Topics will include error analysis, solution of non-linear equations and systems of equations, interpolation, approximation, numerical integration and differentiation and numerical solution of initial-value problems. Prerequisites:

MATH 21100 or MATH 23100. (O,S)

3 Credits

MATH 34800 Modern Data Science with R (LA)

Modern data science brings together programming, statistics, and mathematical skills to understand the world. The course focuses on data visualization and modeling, while also covering topics related to data management and programming in the R environment. Students use theory together with programming and statistical methods to develop the capacity to create new and unique models, visualizations, and/or solutions in data-based multidisciplinary investigations into problems from a variety of fields. Prerequisites: MATH 11200 (may be taken concurrently) and MATH 24600. (F,Y)

3 Credits

MATH 36200 Modern Geometry (LA)

Rigorous development of Euclidean and hyperbolic geometry from both a metric and synthetic point of view. Some topics in transformational geometry are also covered. Prerequisites: One three to four credit level 2 MATH course with a grade of C- or better. (F,O)

Attributes: NS

4 Credits

MATH 39000 Selected Topics in Mathematics (LA)

Topics to be determined by instructors and department. Fulfills a required mathematics elective. This course may be repeated for credit when topics vary. Prerequisites: Permission of instructor. (IRR)

Attributes: NS

1-4 Credits

MATH 39100-39200 Independent Study: Mathematics (LA)

Individual study of selected subjects extending the student's mathematical knowledge. This course may be repeated for credit for different studies. Does not fulfill a required mathematics elective.

Prerequisites: MATH 27000 with a grade of C- or better. (IRR)

Attributes: UND

1-3 Credits

MATH 39700 Junior Seminar (LA)

Students will work with faculty on focused mathematical investigations. Research problems will be presented by faculty teaching MATH 39810 Research Experience in Mathematics. Students will attend a variety of talks related to mathematics. Weekly problem solving related to research topics. Prerequisites: One level-2 MATH course. Pass/fail only. (F, Y)

Attributes: NS, UND

1 Credit

MATH 39810 Research Experience in Mathematics (LA)

Students actively participate in mathematical investigation and exposition, working collaboratively on research questions. Review of relevant literature and research methods will be incorporated. Students are required to present their findings both in writing (consistent with the standards of the discipline) and in public presentations. Topics vary by instructor. Prerequisites: MATH 39700; permission of instructor. (S,Y)

Attributes: NS

3 Credits

MATH 41000 Selected Topics in Continuous Mathematics (LA)

Emphasis is on mathematical topics in which the concept of continuity plays a key role. Specific content varies. Topics may include but are not limited to, topology, manifold theory, fractal geometry, advanced real analysis, differential topology, advanced differential equations, and continuous dynamical systems. Prerequisites: One level-3 mathematics course with a grade of C- or better; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 41100 Complex Analysis (LA)

Students explore the theory of functions defined in the complex plane, highlighting the interplay between geometric visualization and analysis. Topics include the geometry of analytic mappings, power series, Cauchy's Theorem, and the Residue Theorem. Connections to other areas of mathematics and to other scientific fields will be explored through applications. Prerequisites: One level-3 mathematics course with a grade of C- or better; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 42000 Selected Topics in Discrete Mathematics (LA)

Emphasis is placed on mathematical topics principally concerned with discrete entities. Specific content varies. Topics include, but are not limited to, number theory, fair division, game theory, discrete dynamical systems and advanced topics in group, ring, or field theory. Prerequisites: One level-3 mathematics course; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 42100 Graph Theory and Combinatorics (LA)

Topics in graph theory include basic properties of graphs, Eulerian trails, Hamilton chains, trees, and may include the chromatic polynomial, planar graphs, and the independence number. Topics in combinatorics include the pigeonhole principle, permutations and combinations, the binomial theorem, and may include generating functions, Catalan numbers, and Stirling numbers. Prerequisites: One level-3 mathematics course with a grade of C- or better; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 43000 Selected Topics in Applied Mathematics (LA)

Emphasis is on mathematics topics in an applied setting. Topics may include, but are not limited to mathematical modeling, partial differential equations, wavelets, scheduling theory, applied dynamical systems, and actuarial mathematics. Prerequisites: One level-3 mathematics course with a grade of C- or better; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 43100 Numerical Analysis (LA)

Theory and applications of numerical techniques. Topics will include error analysis, solution of non-linear equations and systems of equations, interpolation, approximation, numerical integration and differentiation and numerical solution of initial-value problems. Prerequisites: One level-3 mathematics course with a grade of C- or better; junior standing. (IRR)

Attributes: NS

3 Credits

MATH 48000 Connections in Advanced Mathematics (LA)

Study of connections and relationships among various disciplines within mathematics. Specific content varies. Topics may include, but are not limited to, the following: historical development of mathematics and various philosophies of mathematics, cultural similarities and differences in viewpoints and developments in mathematics, cross-discipline approaches that combine subdisciplines such as probability techniques in number theory and random graph theory, field theory and geometric constructions, and algebraic topology. This course may be repeated for credit when topics vary. Prerequisites: One 300-level course in mathematics with a grade of C- or better. (F,Y)

Attributes: NS

3 Credits

MATH 49000 Selected Topics in Advanced Mathematics (LA)

Topics to be selected by instructor and students. Fulfills a required mathematics elective. This course may be repeated for credit when topics vary. Prerequisites: Permission of instructor. (IRR)

Attributes: NS

3 Credits

MATH 49200 Independent Study: Mathematics (LA)

Individual study of selected subjects extending the student's mathematical knowledge. Fulfills a required mathematics elective. This course may be repeated for credit. Prerequisites: Permission of instructor.

Attributes: NS, UND

1-3 Credits

MATH 49201 Independent Study: Math (LA)

Reading on selected advanced subjects, with frequent, informal discussions with the instructor. Fulfills a required mathematics elective. This course may be repeated for credit. Prerequisites: Permission of instructor.

Attributes: NS

1-3 Credits

MATH 49300 Honors Course in Math (LA)

Preparation of honors thesis in partial fulfillment of requirement for graduation with honors in mathematics. Prerequisites: Honors standing in mathematics. (IRR)

Attributes: NS

1-2 Credits

MATH 49400 Honors Course: Math (LA)

Preparation of honors thesis in partial fulfillment of requirement for graduation with honors in mathematics. Prerequisites: Honors standing in mathematics. (IRR)

Attributes: NS

1-2 Credits

MATH 49800 Capstone in Mathematics I (LA)

Students develop a capstone project proposal that will be completed in MATH 49900. Students reflect on how their prior math courses have prepared them for their project. Prerequisites: Junior standing; six credits in mathematics at level 3 or 4 with a grade of C- or better. (S,Y)

Attributes: CP, WI

1 Credit

MATH 49900 Capstone in Mathematics II (LA)

Students reflect upon the field of mathematics via an integrative project developed in concert with a faculty mentor. Students analyze mathematical ideas related to their projects and integrate this knowledge with ideas learned in the mathematics curriculum. Students complete a comprehensive thesis (begun in MATH 49800) and give a public presentation. Prerequisites: MATH 49800 with a grade of C- or better. (F, Y)

Attributes: CP, WI

2 Credits