MATHEMATICS (MAT)

"In most sciences one generation tears down what another has built and what one has established another undoes. In mathematics alone each generation adds a new story to the old structure."

-Hermann Hankle, 1839-1873

Mathematics is the logical development and application of abstract forms and systems arising from natural phenomena, human activities, and ideas within mathematics itself. It is composed of the major fields of geometry/topology, algebra, and analysis which are divided into more than sixty fields of specialization.

As an academic discipline, mathematics shapes and sharpens the rational capabilities of the mind. It is a mode of thinking which empowers the individual to absorb new ideas, adapt to rapid change, cope with ambiguity, recognize patterns, solve unconventional problems, analyze complexity, work with abstract concepts and relationships, detect bias, assess risks, and suggest alternatives. Increasingly these are the capacities of mind that are needed for responsible citizenship and successful careers.

As an application tool, mathematics uncovers the structures and relationships that help us understand the nature and problems of the world around us. Mathematics expresses its concepts in symbols and graphic representations within a framework of logical inference which serves as the universal language for communicating technical knowledge.

Resources and Instruction

Major in Mathematics: A major in mathematics is one of the finest courses of study for developing ability in analytical thinking. Combined with an appropriate concentration of application courses, a major in mathematics prepares the student for a wide range of career and educational opportunities.

Mathematics majors typically find employment as financial and marketing analysts, technical support consultants in research and development, business problem-solvers using operations research techniques, statisticians, actuaries...the list is endless. Companies in the computer, communications, and aerospace industries employ many mathematics majors, as do oil companies, banks, insurance companies, consulting firms, manufacturing companies, utilities, research agencies, and almost every bureau and branch of the federal government.

Students may also pursue graduate study in pure or applied mathematics, operations research, statistics, business, computing, and economics as well as many areas in the natural, life, and social sciences.
Mathematics can also be the basis of a teaching career at the secondary or college level.

Minor in Mathematics: A minor in mathematics is a valuable complement to most majors. This is especially true for majors in the natural sciences, and in the life and social sciences the necessity of mathematical sophistication is growing. A minor in mathematics significantly improves a student's employment potential.

Course of Study

A. A major in mathematics consists of:
1. At least 36 credits in mathematics including:
   a. Mathematics core: MAT 221, 222, 223, 224, 231, 333, 351, 421, 431.
   b. Depth: At least one of MAT 422, 423, 432.
   c. Applications: At least one of MAT 352, 361, 371, 373, 475.
2. Collateral requirement: CSC 131.
3. A concentration of at least 12 credits in an application area other than mathematics.

Grade Point Average: To have a major in mathematics approved for graduation, a student must have a minimum cumulative GPA of 2.50 in courses selected by the student to satisfy the major. In addition, a grade of C or better must be achieved in at least 12 of the credits in the mathematics courses numbered 300 or above.

B. A minor in mathematics consists of at least 22 credits in mathematics at the 200 level or higher including:
1. Mathematics core: MAT 221, 222, 223.
2. Continuous or discrete option: MAT 224 or MAT 230.
3. Applications: One course chosen from MAT 351, 352, 361, 371, 373, 432, 475.

Note: The minor in mathematics differs from a teaching minor in mathematics at both the elementary and secondary level. For more information on this minor, please see the Education Department.

Grade Point Average: To have a minor in mathematics approved for graduation, a student must have a minimum GPA of 2.00 in all mathematics courses selected by the student to satisfy the minor.

Placement testing in mathematics is required of all students who need to enroll in mathematics at Wisconsin Lutheran College for the first time. This includes transfer students having an uncertain attainment level or college mathematics credits more than two years old. Students desiring advanced placement in calculus also need to demonstrate proficiency on the placement exams. In all cases the department of mathematics will decide which students require placement testing. The department of mathematics determines a student's mathematics placement on the basis of high school grades, ACT/SAT scores, placement testing, and (if necessary) personal interview.

Course Descriptions

MAT 116 Mathematics for Life. 3 cr.
Mathematical topics relevant to living in modern society with special emphasis placed upon the uses of mathematical ideas and mathematical thought processes. Topics include critical thinking, problem-solving, sets, logic, matrices, and geometry. Especially appropriate for students seeking the BA degree who do not plan on taking any additional mathematics courses such as statistics, or calculus.

MAT 117 Elementary Statistics. 3 cr.
Statistical concepts and methods for application in other disciplines. Descriptive statistics, bivariate linear models, probability, discrete and normal distributions, central limit theorem, estimation, hypothesis testing. MAT 117 does not count toward a mathematics major or minor.

MAT 120 Precalculus. 4 cr.
Fundamental principles of college algebra and trigonometry essential to the study of calculus. Emphasis on functions and their graphs, including polynomials, rational functions, exponential and logarithmic functions, trigonometric functions. Prereq: placement

MAT 210 Survey of Calculus. 4 cr.
Survey of concepts and applications of differential and integral calculus for BA and Business Administration majors. Only one of MAT 210 and MAT 221 may be taken for credit. Prereq: placement or MAT 120 with a grade of BC or better.

MAT 221 Calculus 1. 4 cr.
Intensive introduction to single-variable calculus. Functions, limits and continuity, differentiation of algebraic and transcendental functions, introduction to integration and differential equations. Application topics and lab assignments. Prereq: placement or credit in MAT 120 with a grade of BC or better.

MAT 222 Calculus 2. 4 cr.
Continuation of MAT 221. Applications of integration, integration techniques, indeterminate forms and improper integrals, sequences and series, parametric equations in the plane, polar coordinates, first and second order ordinary differential equations. Application topics and lab assignments. Prereq: placement or MAT 221 with a grade of C or better.

MAT 223 Calculus 3. 4 cr.
Intensive introduction to multi-variable calculus. Analytic geometry of vectors, vector-valued functions, continuity and partial differentiation for functions of several variables, multiple integration, vector fields, theorems of Green, Gauss, and Stoke. Application topics, assignments using Maple. Prereq: placement or MAT 222 with a grade of C or better.

MAT 224 Ordinary Differential Equations. 4 cr.
Ordinary differential equations and solution methods, linear systems of differential equations, selected topics. Modeling emphasis, several lab assignments. Prereq: MAT 222. MAT 223 and 233 recommended.

MAT 230 Introduction to Discrete Mathematics. 4 cr.
An introduction to the various tools and techniques in discrete mathematics. Topics include mathematical logic, sets, relations, algorithms, combinatorics, recursion, graph theory, trees, network models, and Boolean algebras. Prereq: MAT 222 or permission of the instructor.

MAT 231 Foundations of Higher Mathematics. 3 cr.
A transitional course to prepare students for upper-level courses in mathematics. Logic, proof techniques, set theory, functions, countable and uncountable sets, finite induction, equivalence relations. Topics selected by the instructor. Prereq: MAT 222 or permission of the instructor.

MAT 333 Introduction to Linear Algebra. 4 cr.
Matrix algebra, Gauss-Jordan elimination, vector spaces, linear independence, determinants, orthogonality, linear transformations and their matrix representation, eigenvalues and eigenvectors, and applications. Prereq: MAT 222 and junior standing or consent of instructor.

MAT 340 Survey of Geometry. 3 cr.
Selected topics in Euclidean and non-Euclidean geometries, Hilbert's axioms and neutral geometry, hyperbolic geometry, historical perspectives, philosophy of mathematics. Emphasis on the role and independence of the parallel postulate. Prereq: junior standing and MAT 231.

MAT 351 Introduction to Probability. 3 cr.
Probability in discrete and continuous sample spaces, random variables, distribution functions, marginal and conditional distributions, expectation, independence, limit theorems, basic distributions. Prereq: junior standing and MAT 222, MAT 223 recommended.

MAT 352 Introduction to Statistics. 3 cr.
Random samples, estimation, sampling distributions of estimators, t and Chi-Square distributions, confidence intervals, hypothesis testing, nonparametric methods, linear models. Prereq: MAT 351.

MAT 361 Introduction to Operations Research. 3 cr.
Survey of topics in linear programming and applications, network and flow models, dynamic programming, and selected topics. Emphasis on modeling. Prereq: MAT 222.

MAT 371 Numerical Analysis. 3 cr.
Numerical methods for digital computers: error analysis, solution of nonlinear equations and systems of equations, direct methods for solving linear systems, discrete curve fitting, interpolation. Prereq: junior standing, MAT 224, and CSC 131.

MAT 373 Introduction to Cryptography. 3 cr.
An introduction to the field of classical and mathematical cryptography. Topics include linguistic techniques and classical cryptographic methods, key exchange protocols, public key cryptography, factoring techniques and primality testing, digital signatures, hash functions, secret sharing schemes, and relevant number theoretic methods. Prereq: sophomore standing and MAT 222 or MAT 230. This course is cross-listed with CSC 373.

MAT 421 Analysis 1. 3 cr.
Classical real analysis: completeness of real numbers, sequences and series, metric topology of Euclidean space, continuity, uniform continuity, differentiation, and uniform convergence. Prereq: MAT 231 or permission of instructor.

MAT 422 Analysis 2. 3 cr.
Continuation of MAT 421: differentiable mappings, inverse and implicit function theorems, theory of integration, and selected topics. Prereq: MAT 421.

MAT 423 Complex Analysis. 3 cr.
Complex numbers and analytic functions, Cauchy integral theorems and formulas, Taylor series and entire functions, singularities and the Laurent expansion, residues. Prereq: MAT 421

MAT 431 Abstract Algebra 1. 3 cr.
Group theory: symmetry, subgroups, cyclic groups, permutations, Lagrange's theorem, factor groups, homomorphisms, isomorphisms, direct products, finite abelian groups. Introduction to rings and integral domains. Prereq: junior standing and MAT 231.

MAT 432 Abstract Algebra 2. 3 cr.
Continuation of MAT 431: polynomial rings, unique factorization, divisibility in integral domains. Introduction to field theory: splitting fields, algebraic extensions, finite fields, geometric constructions. Advanced topics in groups and fields. Prereq: MAT 431.

MAT 445 Topology. 3 cr.
Topological spaces and subspaces, basis and subbasis, accumulation points, continuity and homeomorphism; metric, product, and quotient spaces; connectness, compactness, countability axioms, separation axioms, Urysohn's lemma and metrization theorem, Tietze extension theorem, Tychonoff's theorem. Prereq: MAT 421.

MAT 475 Partial Differential Equations. 3 cr.
Introduction to the classical parabolic, hyperbolic, and elliptic partial differential equations with special consideration to heat transfer, wave motion, and potential theory. Various initial/boundary conditions and applications. Transform methods, equations in several coordinate systems, and numerical approximations. Modeling will be an integral part of the course. Prereq: MAT 224.

MAT x91 Special Topics. 3 cr.
Selected advanced topics in mathematics. Content varies. Course may be taken for credit more than once with different topics. Offered as needed. Prereq: consent of instructor.

MAT 199-499 Independent Study. 1-3 cr.
By arrangement with instructor.