

# MATHEMATICS (MATH)

## MATH F051 Math Skills Review

1 Credit

Offered As Demand Warrants

Develops and reviews basic mathematical terminology, theory and operations as outlined by the Alaska State Mathematics Standards. Mathematics topics focus on reviewing the six basic "strands" of mathematical content: numeration, measurement, estimation and computation, function and relationship, geometry, and statistics and probability. Approaches to problem solving will emphasize the process of mathematical thinking, communication and reasoning. It is an appropriate course for those preparing for the High School Qualifying Exam in Alaska or those needing a review of basic math skills in preparation for a math placement test at UAF. May be repeated for a total of three credits.

**Lecture + Lab + Other:** 1 + 0 + 0

## MATH F053 SAT/ACT Math Prep and Review

1 Credit

Offered As Demand Warrants

This course will review basic concepts and practice math test taking skills to help prepare for the ACT and SAT tests.

**Lecture + Lab + Other:** 1 + 0 + 0

## MATH F054 Prealgebra

3 Credits

Offered As Demand Warrants

Basic concepts of prealgebra mathematics. Topics include operations and applications of whole numbers, integers, fractions, decimals, ratios and proportions, percents, geometry and measures, evaluation of algebraic expressions and applications.

**Prerequisites:** DEVS F111 (may be taken concurrently); and appropriate placement scores.

**Lecture + Lab + Other:** 3 + 0 + 0

## MATH F054A Modularized Mastery Math: Prealgebra Module A

1 Credit

Offered As Demand Warrants

This course covers one credit of MATH F054 Prealgebra and includes the following topics: identifying and solving basic linear equations involving whole numbers, integers, decimals and fractions, solving ratio and proportion problems, solving percent problems, and solving applied problems. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting,

**Prerequisites:** Appropriate placement test score within one calendar year; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0

## MATH F054B Modularized Mastery Math: Prealgebra Module B

1 Credit

Offered As Demand Warrants

This course covers one credit of MATH F054 Prealgebra and includes the following topics: identifying and solving basic linear equations involving whole numbers, integers, decimals and fractions, solving ratio and proportion problems, solving percent problems, and solving applied problems. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting,

**Prerequisites:** Grade of B or better in MATH F054A; or appropriate placement test scores taken within one calendar year; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0

## MATH F054C Modularized Mastery Math: Prealgebra Module C

1 Credit

Offered As Demand Warrants

This course covers one credit of MATH F054 Prealgebra and includes the following topics: identifying and solving basic linear equations involving whole numbers, integers, decimals and fractions, solving ratio and proportion problems, solving percent problems, and solving applied problems. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting, Prerequisite courses and/or placement exams must be taken within one calendar year.

**Prerequisites:** Grade of B or better in MATH F054B; or appropriate placement test scores; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0

## MATH F055 Elementary Algebra

3 Credits

Offered As Demand Warrants

Topics include evaluation and simplifying algebraic expressions, polynomials, factoring, integer exponents, rational expressions, solutions of linear equations and inequalities, graphing lines, solving systems of linear equations, solving quadratic equations by factoring, and some rational equations. Prerequisite courses and/or placement exams must be taken within one calendar year prior to commencement of the course.

**Prerequisites:** DEVS F111 (may be taken concurrently); and grade of C or better in MATH F054 or ABUS F155, or appropriate placement scores.

**Lecture + Lab + Other:** 3 + 0 + 0

## MATH F055D Modularized Mastery Math: Elementary Algebra Module D

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH F055 Elementary Algebra course and includes the following topics: simplifying algebraic expressions, solving linear equations in one variable, solving linear and compound inequalities in one variable, applications of linear equations and solving formulas. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting.

**Prerequisites:** Grade of B or better in MATH F054, or ABUS F155; or appropriate placement test scores; permission of instructor required; prerequisite courses and/or placement exams must be taken within one calendar year.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F055E Modularized Mastery Math: Elementary Algebra Module E**

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH F055 Elementary Algebra course and includes the following topics: linear equations in two variables, graphing linear equations, find the slope of linear equations, writing equations of lines, exponent rules and operations on polynomials. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting.

**Prerequisites:** Grade of B or better in MATH F055D taken within one calendar year; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F055F Modularized Mastery Math: Elementary Algebra Module F**

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH F055 Elementary Algebra course and includes the following topics: factoring polynomials, solving quadratic equations by factoring, simplifying rational expressions, operations with rational expressions, complex fractions, solving rational equations and applications of quadratic and rational equations. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting.

**Prerequisites:** Grade of B or better in MATH F055E taken within one calendar year; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F056 Math Fast Track: Prealgebra/Elementary Algebra Review**

1 Credit

Offered As Demand Warrants

A 20-hour intensive review of math concepts available prior to each semester. Covers prealgebra and elementary algebra topics to prepare qualified students to potentially improve their math course placement. Students should have a history of being successful in equivalent levels of math, although they may not recall enough information to place well on the placement test. Students who are successful in this class have the possibility of advancing through one or two semesters of development math.

**Prerequisites:** Placement into MATH F054 or MATH F055.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F061 Review of Elementary Algebra**

1 Credit

Offered As Demand Warrants

Designed to assist students in reviewing material covered by MATH F055. Individuals who have not previously taken an elementary algebra course are recommended to enroll in MATH F055. Available via UAF eCampus only.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F062 Alternative Approaches to Math: Elementary Algebra**

3 Credits

Offered As Demand Warrants

Algebraic topics. Includes operations with polynomial expressions, first- and second-degree equations, graphing, integral and relational exponents, and radicals using alternative teaching styles.

**Prerequisites:** Grade of C- or better in MATH F054; or ABUS F155; or appropriate placement test scores; prerequisite courses and/or placement exams must be taken within one calendar year prior to commencement of the course.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F065 Mathematics Skills**

1-3 Credits

Offered As Demand Warrants

Designed to assist students in reviewing and reinforcing course concepts covered by MATH F054, MATH F055, MATH F062, MATH F105 and MATH F105N. Consists of instruction which may include lab instruction, individual student work or group work. May be repeated.

**Special Notes:** Recommended for students who need more time and help to master the material in developmental math courses.

**Lecture + Lab + Other:** 1-3 + 0 + 0

**MATH F066 Advanced Math Fast Track: Elementary/Intermediate Algebra Review**

1 Credit

Offered As Demand Warrants

A 20-hour intensive review of math concepts available prior to each semester. Covers elementary and intermediate algebra topics to prepare qualified students to potentially improve their math course placement. Students should have a history of being successful in equivalent levels of math, although they may not recall enough information to place well on the placement test. Students who are successful in this class have the possibility of advancing through one or two semesters of development math.

**Prerequisites:** Placement into MATH F055 or MATH F105 or MATH F105N.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F068 Math Essentials**

4 Credits

Offered As Demand Warrants

Arithmetic and introductory algebra. Solve problems related to operations and properties of real numbers; proportion; percent; evaluation of algebraic expressions; solution and graphs of linear equations and inequalities; solving systems of linear equations; exponent rules; operations on polynomials; factoring; fundamental operations with rational expressions; solutions and applications of quadratic equations. Prerequisite course and/or placement exams must be taken within one calendar year prior to commencement of the course.

**Prerequisites:** DEVS F111 (may be taken concurrently); and appropriate placement score.

**Lecture + Lab + Other:** 4 + 0 + 0

**MATH F071 Review of Intermediate Algebra**

1 Credit

Offered As Demand Warrants

Course reviews material covered by MATH F105. Individuals who have not taken an intermediate algebra course on the high-school level are recommended to enroll in MATH F105. Available via UAF eCampus only.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F105 Intermediate Algebra**

3 Credits

Offered As Demand Warrants

Topics include expressions, equations and applications involving linear, absolute value, radical, quadratic, rational and radical functions; graphs of absolute value, radical, quadratic, exponential and logarithmic functions; functions and their inverses; and introduction to exponential and logarithmic functions. To matriculate to MATH F151X from MATH F105, students must earn a grade of B or higher.

**Prerequisites:** Grade of C or better in MATH F055, MATH F062, MATH F068, or appropriate placement test scores; prerequisite courses and/or placement exams must be taken within one calendar year prior to commencement of the course.

**Lecture + Lab + Other:** 3 + 0 + 0**MATH F105G Modularized Mastery Math: Intermediate Algebra Module G**

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH F105 Intermediate Algebra course and includes the following topics: solving systems of equations and applications, simplifying radicals and expressions with rational exponents, performing operations on radical expressions, solving radical equations and performing operations on complex numbers. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting. Prerequisite courses and/or placement exams must be taken.

**Prerequisites:** Grade of B or better in MATH F055 or MATH F069 or appropriate placement test scores; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0**MATH F105H Modularized Mastery Math: Intermediate Algebra Module H**

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH F105 Intermediate Algebra course and includes the following topics: review of solving quadratic equations by factoring, solving quadratic equations that are not factorable, relations and functions, graphs and transformations of functions, quadratic functions and their graphs, performing operations on functions, compositions of functions and applications of quadratic equations and functions. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting.

**Prerequisites:** Grade of B or better in MATH F105G taken within one calendar year; permission of instructor is required.

**Lecture + Lab + Other:** 1 + 0 + 0**MATH F105J Modularized Mastery Math: Intermediate Algebra Module J**

1 Credit

Offered As Demand Warrants

This course covers one credit of the MATH Intermediate Algebra course and includes the following topics: solving absolute value equations and inequalities, solving linear and compound linear inequalities, solving quadratic and rational inequalities, inverse functions, exponential and logarithmic functions, properties of logarithms and solving exponential and logarithmic equations. Topics are split into mini-modules and worked until mastery is achieved. Some mini-modules may be skipped if a student already demonstrates mastery of them. Computers will be used within a structured and independent learning setting.

**Prerequisites:** Grade of B or better in MATH F105H taken within one calendar year; permission of instructor required.

**Lecture + Lab + Other:** 1 + 0 + 0**MATH F105N Intensive Intermediate Algebra**

4 Credits

Offered As Demand Warrants

Includes exponents, radicals, graphing, systems of equations, quadratic equations and inequalities, logarithms and exponentials and complex numbers using alternative teaching styles.

**Prerequisites:** MATH F055, MATH F055F, MATH F062, MATH F068, MATH F105, MATH F105J, or appropriate placement scores; prerequisite courses and placement scores must be taken within one calendar year.

**Lecture + Lab + Other:** 4 + 0 + 0**MATH F113X Numbers and Society (m)**

3 Credits

Offered Fall and Spring

Numbers and data help us understand our society. In this course, we develop mathematical concepts and tools to understand what numbers and data can tell us. Topics may include the mathematics of elections and voting, modeling population growth, financial mathematics, polls and surveying, and introductory probability and descriptive statistics.

**Prerequisites:** An appropriate score on the math placement test, or MATH F105, MATH F105N or MATH F105J.

**Attributes:** UAF GER Mathematics Req**Lecture + Lab + Other:** 3 + 0 + 0**MATH F114X Patterns and Society**

3 Credits

Offered Fall and Spring

Patterns are present in every aspect of daily life. In this course, we develop mathematical concepts and tools to understand what patterns can tell us. Topics may include dividing things fairly; determining efficient routes and schedules; analyzing networks and their properties; the mathematics of symmetry, fractal geometry, and patterns in

**Prerequisite:** An appropriate score on the math placement test, MATH F105, MATH F105N or MATH F105J.

**Attributes:** UAF GER Mathematics Req**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F122S Essential Precalculus with Applications Skills Workshop**

1 Credit

Offered Fall and Spring

Directed study of topics in MATH F122X; emphasis will be placed on problem solving and mathematical communication. Also included will be instruction on how to be successful in precalculus and mathematics-based courses.

**Prerequisites:** Previous W or grade below C- in MATH F122X; or placement into MATH F122X; or departmental recommendation.

**Corequisite:** MATH F122X.

**Special Notes:** Credit may be earned for taking MATH F122R or MATH F122S, but not for both.

**Lecture + Lab + Other:** 0.5 + 1.5 + 0

**MATH F122X Essential Precalculus with Applications (m)**

3 Credits

Offered Fall and Spring

A study of various classes of functions, exploring their numeric, algebraic and graphical aspects. Function classes include linear, quadratic, rational, exponential and logarithmic. This course is appropriate for students in programs relating to business and economics or life sciences or students intending to take MATH F230X.

**Prerequisites:** Appropriate placement score, MATH F105, MATH F105N or MATH F105J.

**Special Notes:** Credit may be earned for MATH F151X or MATH F122X, but not for both.

**Attributes:** UAF GER Mathematics Req

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F151S College Algebra for Calculus Skills Workshop**

1 Credit

Offered Fall and Spring

Directed study of topics in MATH F151X. Emphasis will be placed on problem-solving and mathematical communication. Also included will be instruction on how to be successful in College Algebra for Calculus and mathematics-based courses.

**Prerequisites:** Previous W or grade below C- in MATH F151X; or placement into MATH F151X; or departmental recommendation.

**Corequisites:** MATH F151X.

**Special Notes:** Credit may be earned for taking MATH F151R or MATH F151S, but not for both.

**Lecture + Lab + Other:** 0.5 + 1.5 + 0

**MATH F151X College Algebra for Calculus (m)**

4 Credits

Offered Fall and Spring

Study of algebraic, logarithmic and exponential functions; systems of equations; applications.

**Prerequisites:** Appropriate score on the math placement test, B or better in MATH F105, B or better in MATH F105J or C or better in MATH F105N.

**Special Notes:** Credit may be earned for MATH F151X or MATH F122X, but not for both; Only eight credits total may be earned from MATH F151X, MATH F152X and MATH F156X.

**Attributes:** UAF GER Mathematics Req

**Lecture + Lab + Other:** 4.5 + 0 + 0

**MATH F152X Trigonometry (m)**

3 Credits

Offered Fall and Spring

A study of trigonometric functions including graphing, identities, inverse trigonometric functions, solving equations and polar coordinates; applications.

**Prerequisites:** MATH F151X (may be taken concurrently) or placement.

**Special Notes:** Only eight credits total may be earned from MATH F151X, MATH F152X and MATH F156X.

**Attributes:** UAF GER Mathematics Req

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F156S Precalculus Skills Workshop**

1 Credit

Offered Fall and Spring

Directed study of topics in precalculus. Emphasis will be placed on problem-solving and mathematical communication. Also included will be instruction on how to be successful in precalculus and mathematics-based courses.

**Prerequisites:** Previous W or grade below C- in MATH F156X; or placement into MATH F156X; or departmental recommendation.

**Corequisites:** MATH F156X.

**Special Notes:** Credit may be earned for taking MATH F156R or MATH F156S, but not for both.

**Lecture + Lab + Other:** 0.5 + 1.5 + 0

**MATH F156X Precalculus (m)**

4 Credits

Offered Fall and Spring

Various classes of functions and their graphs are explored numerically, algebraically and graphically. Function classes include polynomial, rational, exponential, logarithmic and trigonometric. Skills and concepts needed for calculus are emphasized. This class is intended for students intending to take MATH F251X.

**Prerequisites:** Placement into MATH F156X.

**Special Notes:** Only eight credits total may be earned from MATH F151X, MATH F152X and MATH F156X.

**Attributes:** UAF GER Mathematics Req

**Lecture + Lab + Other:** 4 + 1 + 0

**MATH F211 Mathematics for Elementary School Teachers (m)**

3 Credits

Offered Fall

Elementary set theory, numeration systems, and algorithms of arithmetic, divisors, multiples, integers and introduction to rational numbers.

Emphasis on classroom methods. Restricted to Elementary Education majors; others by permission of instructor.

**Prerequisites:** MATH F122X; or MATH F151X; or MATH F156X; or placement.

**Lecture + Lab + Other:** 3 + 1 + 0

**MATH F212 Mathematics for Elementary School Teachers II (m)**

3 Credits

Offered Spring

A continuation of MATH F211. Real number systems and subsystems, logic, informal geometry, metric system, probability and statistics.

Emphasis on classroom methods.

**Prerequisites:** MATH F211.

**Lecture + Lab + Other:** 3 + 1 + 0

**MATH F230S Essential Calculus with Applications Skills Workshop**  
1 Credit  
Offered Fall and Spring  
Directed study of topics in MATH F230X; emphasis will be placed on problem-solving and mathematical communication. Also included will be instruction on how to be successful in calculus and other mathematics-based courses.  
**Prerequisites:** Previous W or grade below C- in MATH F230X; or placement into MATH F230X; or department recommendation.  
**Corequisites:** MATH F230X.  
**Special Notes:** credit may be earned for taking MATH F230R or MATH F230S, but not for both.  
**Lecture + Lab + Other:** 0.5 + 1.5 + 0

**MATH F230X Essential Calculus with Applications**  
3 Credits  
Offered Fall and Spring  
An introduction to the key ideas of differential and integral calculus, and their uses in business, economics and the life sciences. This course emphasizes a solid conceptual understanding, along with calculation techniques for basic applications. MATH F230X cannot serve as a prerequisite for MATH F252X.  
**Prerequisites:** MATH F122X; or MATH F151X; or MATH F156X; or placement.  
**Special Notes:** Credit cannot be earned for both MATH F230X and MATH F251X.  
**Attributes:** UAF GER Mathematics Req  
**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F251L Calculus I Recitation**  
0 Credit  
Offered Fall and Spring  
Recitation section for Calculus I. Activities may include worksheets, quizzes and problem sessions associated with corresponding lecture material from MATH F251X.  
**Corequisites:** MATH F251X.  
**Lecture + Lab + Other:** 0 + 1 + 0

**MATH F251S Calculus I Skills Workshop**  
1 Credit  
Offered Fall and Spring  
Directed study of topics in MATH F251X, emphasis will be placed on problem-solving and mathematical communication. Also included will be instruction on how to be successful in Calculus I and mathematics-based courses.  
**Prerequisites:** Previous W or grade below C- in MATH F251X; or placement into MATH F251X; or departmental recommendation.  
**Corequisites:** MATH F251X.  
**Special Notes:** Credit may be earned for taking MATH F251R or MATH F251S, but not for both.  
**Lecture + Lab + Other:** 0.5 + 1.5 + 0

**MATH F251X Calculus I (m)**  
4 Credits  
Offered Fall and Spring  
A first course in single-variable calculus. Topics include limits; continuity and differentiation of functions; applications of the derivative to graphing, optimization, and rates of change; definite and indefinite integration; and the Fundamental Theorem of Calculus.  
**Prerequisites:** Appropriate score on the math placement test; or MATH F151X and MATH F152X; or MATH F156X.  
**Corequisites:** MATH F251L.  
**Special Notes:** Credit may not be earned for both MATH F251X and MATH F230X.  
**Attributes:** UAF GER Mathematics Req  
**Lecture + Lab + Other:** 4 + 0 + 0

**MATH F252L MATH F252X Recitation**  
0 Credit  
Offered Fall and Spring  
**Co-requisites:** MATH F252X.  
**Lecture + Lab + Other:** 0 + 0 + 0

**MATH F252X Calculus II (m)**  
4 Credits  
Offered Fall and Spring  
Further topics in single-variable calculus, including techniques of integration; applications of integration; convergence of sequences and series; parameterized curves; and polar coordinates.  
**Prerequisites:** MATH F251X.  
**Co-requisites:** MATH F252L.  
**Attributes:** UAF GER Mathematics Req  
**Lecture + Lab + Other:** 4 + 1 + 0

**MATH F253X Calculus III (m)**  
4 Credits  
Offered Fall and Spring  
Multivariable calculus. Topics include vectors in 2- and 3-dimensions; differential calculus of functions of several variables; multiple integration; vector calculus, including Green's and Stokes' Theorem; and applications.  
**Prerequisites:** MATH F252X.  
**Attributes:** UAF GER Mathematics Req  
**Lecture + Lab + Other:** 4 + 0 + 0

**MATH F265 Introduction to Mathematical Proofs (m)**  
3 Credits  
Offered Spring  
Emphasis on proof techniques with topics including logic, sets, cardinality, relations, functions, equivalence, induction, number theory, congruence classes and elementary counting. In addition, a rigorous treatment of topics from calculus or a selection of additional topics from discrete mathematics may be included.  
**Prerequisites:** MATH F252X (may be taken concurrently).  
**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F302 Differential Equations**  
3 Credits  
Offered Fall and Spring  
Nature and origin of differential equations, first order equations and solutions, linear differential equations with constant coefficients, systems of equations, power series solutions, operational methods, and applications.  
**Prerequisites:** MATH F253X.  
**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F305 Geometry**

3 Credits

Offered Spring Even-numbered Years

Topics selected from such fields as Euclidean and non-Euclidean plane geometry, affine geometry, projective geometry, and topology.

**Prerequisites:** MATH F265; MATH F314.**Recommended:** MATH F253X.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F307 Discrete Mathematics**

3 Credits

Offered Spring

Logic, counting, sets and functions, recurrence relations, graphs and trees. Additional topics chosen from probability theory.

**Prerequisites:** MATH F252X.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F314 Linear Algebra**

3 Credits

Offered Fall and Spring

Linear equations, finite dimensional vector spaces, matrices, determinants, linear transformations and characteristic values. Inner product spaces.

**Prerequisites:** MATH F252X.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F316 Introduction to the History and Philosophy of Mathematics**

3 Credits

Offered Spring Odd-numbered Years

Important periods in the history of mathematics, including mathematics of Ancient Babylon, Mesopotamia, Greece, China and India, medieval Europe, the Middle East and the Renaissance; the development of geometry, algebra and calculus. Other areas in the development and philosophy of mathematics will be studied as time permits.

**Prerequisites:** MATH F253X; MATH F265 (may be taken concurrently).**Lecture + Lab + Other:** 3 + 0 + 0**MATH F320 Topics in Combinatorics**

3 Credits

Offered Fall Odd-numbered Years

Introduction to some fundamental ideas of combinatorics. Topics selected from such fields as enumerative combinatorics, generating functions, set systems, recurrence relations, directed graphs, matchings, Hamiltonian and Eulerian graphs, trees and graph colorings.

**Prerequisites:** MATH F265.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F321 Number Theory**

3 Credits

Offered Fall Even-numbered Years

Number theory investigates the properties of the integers, one of the most basic of mathematical sets. Seemingly naive number-theoretic questions stimulated much of the development of modern mathematics! Topics may include classical areas such as primality, congruences, quadratic reciprocity and Diophantine equations, and more recent applications, such as cryptography.

**Prerequisites:** MATH F265.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F371 Probability**

3 Credits

Offered Fall Odd-numbered Years

Probability spaces, conditional probability, random variables, continuous and discrete distributions, expectation, moments, moment generating functions and characteristic functions.

**Prerequisites:** MATH F253X.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F401 Introduction to Real Analysis (W)**

3 Credits

Offered Fall

Completeness of the real numbers and its consequence, convergence of sequences and series, limits and continuity, differentiation, the Riemann integral.

**Prerequisites:** WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; MATH F253X; MATH F265.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F404 Introduction to Topology**

3 Credits

Offered Fall Even-numbered Years

Introduction to topological spaces, set theory, open sets, compactness, connectedness, product spaces, metric spaces and continua.

**Prerequisites:** MATH F253X; MATH F265.**Recommended:** MATH F314 and/or MATH F405.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F405 Abstract Algebra (W)**

3 Credits

Offered Spring

Theory of groups, rings and fields.

**Prerequisites:** WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; MATH F265.**Recommended:** MATH F307 and/or MATH F314.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F408 Mathematical Statistics**

3 Credits

Offered Spring Even-numbered Years

Distribution of random variables and functions of random variables, interval estimation, point estimation, sufficient statistics, order statistics, and test of hypotheses including various criteria for tests.

**Prerequisites:** MATH F371; STAT F200X or STAT F300.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F410 Introduction to Complex Analysis**

3 Credits

Offered Spring

Complex functions including series, integrals, residues, conformal mapping and applications.

**Prerequisites:** MATH F302.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F412 Differential Geometry**

3 Credits

Offered Spring Odd-numbered Years

Introduction to the differential geometry of curves, surfaces, and Riemannian manifolds. Basic concepts covered include the Frenet-Serret apparatus, surfaces, first and second fundamental forms, geodesics, Gauss curvature and the Gauss-Bonnet Theorem. Time permitting, topics such as minimal surfaces, theory of hypersurfaces and/or tensor analysis may be included.

**Prerequisites:** MATH F314; MATH F401.**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F426 Numerical Analysis**

3 Credits

Offered Fall

Direct and iterative solutions of systems of equations, interpolation, numerical differentiation and integration, numerical solutions of ordinary differential equations, and error analysis.

**Prerequisites:** MATH F302 or MATH F314.

**Recommended:** Knowledge of programming.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F430 Topics in Mathematics**

3 Credits

Offered Spring

An elective course in mathematics for majors. Topics will vary from year to year and may be drawn from mathematical biology, numerical linear algebra, graph theory, logic, or other areas of mathematics. May be repeated with permission of instructor for a total of nine credits.

**Prerequisites:** MATH F265.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F432 Introduction to Partial Differential Equations**

3 Credits

Offered Fall

Analysis and solution of partial differential equations. Initial and boundary value problems for parabolic, hyperbolic and elliptic types. Solution methods include separation of variables and Fourier transform.

**Prerequisites:** MATH F302.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F460 Mathematical Modeling**

3 Credits

Offered Fall Odd-numbered Years

Introduction to mathematical modeling using differential or difference equations. Emphasis is on formulating models and interpreting qualitative behavior such models predict. Examples will be taken from a variety of fields, depending on the interest of the instructor. Students develop a modeling project.

**Prerequisites:** COJO F131X or COJO F141X; WRTG F111X; WRTG F211X, WRTG F212X, WRTG F213X or WRTG F214X; MATH F252X.

**Recommended:** one or more of MATH F302, MATH F314, MATH F401, MATH F426, STAT F300 or some programming experience.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F490 Senior Seminar (0)**

2 Credits

Offered Spring

Advanced topics selected from areas outside the usual undergraduate offerings. A substantial level of mathematical maturity is assumed.

**Prerequisites:** COJO F131X or COJO F141X; at least one of MATH F401 or MATH F405; senior standing.

**Lecture + Lab + Other:** 2 + 0 + 0

**MATH F600 Teaching Seminar**

1 Credit

Offered Fall

Fundamentals of teaching mathematics in a university setting. Topics may include any aspect of teaching: university regulations, class and lecture organization, testing, book selection, teaching evaluations, etc. Specific topics will vary on the basis of student and instructor interest. Individual classroom visits will also be used for class discussion. May be repeated for credit.

**Prerequisites:** Graduate standing.

**Lecture + Lab + Other:** 1 + 0 + 0

**MATH F614 Numerical Linear Algebra**

3 Credits

Offered Fall Odd-numbered Years

Algorithms and theory for stable and accurate computation using matrices and vectors on computers. Matrix factorizations, direct and iterative methods for solving linear systems, least squares, eigenvalue and singular value decompositions. Practical implementation and application of algorithms.

**Prerequisites:** MATH F314.

**Recommended:** MATH F401 or MATH F432.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F615 Numerical Analysis of Differential Equations**

3 Credits

Offered Spring Odd-numbered Years

Review of numerical differentiation and integration, and the numerical solution of ordinary differential equations. Main topics to include the numerical solution of partial differential equations, curve fitting, splines, and the approximation of functions. Supplementary topics such as the numerical method of lines, the fast Fourier transform, and finite elements may be included as time permits and interest warrants.

**Prerequisites:** CS F201; MATH F314; MATH F410; MATH F426; MATH F432.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F617 Functional Analysis**

3 Credits

Offered Spring Even-numbered Years

Study of Banach and Hilbert spaces, and continuous linear maps between them. Linear functionals and the Hahn-Banach theorem. Applications of the Baire Category theorem. Compact operators, self adjoint operators, and their spectral properties. Weak topology and its applications.

**Prerequisites:** MATH F314; MATH F401.

**Recommended:** MATH F410; MATH F641.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F631 Algebra I**

4 Credits

Offered Fall Even-numbered Years

Rigorous development of groups, rings and fields.

**Prerequisites:** MATH F405.

**Lecture + Lab + Other:** 4 + 0 + 0

**MATH F632 Algebra II**

3 Credits

Offered Spring Odd-numbered Years

Advanced topics which may be chosen from group theory, Galois theory, commutative or non-commutative algebra, algebraic geometry, homological algebra or other areas.

**Prerequisites:** MATH F631.

**Lecture + Lab + Other:** 3 + 0 + 0

**MATH F641 Real Analysis**

4 Credits

Offered Fall Odd-numbered Years

General theory of Lebesgue measure and Lebesgue integration on the real line. Convergence properties of the integral. Introduction to the general theory of measures and integration. Differentiation, the product measures and an introduction to LP spaces.

**Prerequisites:** MATH F401.

**Lecture + Lab + Other:** 4 + 0 + 0

**MATH F645 Complex Analysis**

4 Credits

Offered Spring Even-numbered Years

Analytic functions, power series, Cauchy integral theory, residue theorem. Basic topology of the complex plane and the structure theory of analytic functions. The Riemann mapping theorem. Infinite products.

**Prerequisites:** MATH F641.**Lecture + Lab + Other:** 4 + 0 + 0**MATH F651 Topology**

4 Credits

Offered Spring Odd-numbered Years

Treatment of the fundamental topics of point-set topology. Separation axioms, product and quotient spaces, convergence via nets and filters, compactness and compactifications, paracompactness, metrization theorems, countability properties, and connectedness. Set theory as needed for examples and proof techniques.

**Prerequisites:** MATH F401 or MATH F404.**Lecture + Lab + Other:** 4 + 0 + 0**MATH F658 Topics in Geometry**

3 Credits

Offered Fall Even-numbered Years

Elective topics in geometry. Recent offerings include configurations of points and lines; topology and differential geometry of surfaces; polyhedra and polytopes.

**Prerequisites:** Linear algebra; geometry; undergraduate real analysis; undergraduate abstract algebra.

**Lecture + Lab + Other:** 3 + 0 + 0**MATH F660 Advanced Mathematical Modeling**

3 Credits

Offered Spring Even-numbered Years

The mathematical formulation and analysis of problems arising in the physical, biological, or social sciences. The focus area of the course may vary, but emphasis will be given to modeling assumptions, derivation of model equations, methods of analysis, and interpretation of results for the particular applications. Examples include heat conduction problems, random walk processes, molecular evolution, perturbation theory. Students will develop a modeling project as part of the course requirements.

**Prerequisites:** Permission of instructor.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F661 Optimization**

3 Credits

Offered Fall Even-numbered Years

Linear and nonlinear programming, simplex method, duality and dual simplex method, post-optimal analysis, constrained and unconstrained nonlinear programming, Kuhn-Tucker conditions. Applications to management, physical and life sciences. Computational work with the computer.

**Prerequisites:** Knowledge of calculus, linear algebra and computer programming.

**Lecture + Lab + Other:** 3 + 0 + 0**MATH F663 Graph Theory**

3 Credits

Offered Fall Odd-numbered Years

A survey of modern techniques in graph theory; topics may include graphs and digraphs, trees, spanning trees, matchings, graph connectivity, graph coloring, planarity, cycles, and extremal problems.

**Prerequisites:** MATH F314; MATH F320.**Lecture + Lab + Other:** 3 + 0 + 0**MATH F665 Topics in Graduate Mathematics**

3 Credits

Offered As Demand Warrants

Elective courses in graduate mathematics offered by faculty on a rotating basis. Topics may include, but are not limited to, graph theory, glaciology modeling, general relativity, mathematical biology, Galois theory and numerical linear algebra. May be repeated for credit with permission of instructor.

**Lecture + Lab + Other:** 3 + 0 + 0**MATH F692 Seminar**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**MATH F698 Non-thesis Research/Project**

1-6 Credits

**Lecture + Lab + Other:** 0 + 0 + 0**MATH F699 Thesis**

1-9 Credits

**Lecture + Lab + Other:** 0 + 0 + 0