

# M - Mathematics

## M 065. Pre-Algebra. 4 Credits. (4 Lec) F,S

Offered by Gallatin College. This instructor-taught course covers basic concepts relating to fractions, decimals, ratios, proportions, percent, selected geometry topics, topics of signed numbers, and 1-variable linear equations. The course is offered as a review and/or preparation for further studies in Mathematics. This course is equivalent to M 085. Common final.

## M 066. Pre-Algebra Lab and Study. 1 Credit. (1 Rct) F

Offered by Gallatin College. Students enrolled in M 065 co-enroll in this course for additional instruction and practice with M 065 curriculum and Math study skills. This course will help students understand Math concepts, practice course material, and prepare for Math tests. Course is offered pass/fail.

## M 085. Prealgebra. 4 Credits. (4 Ind) F,S

Offered by Gallatin College. An accelerated lab-based course designed for students who need a review of prealgebra concepts and are prepared to learn in a self-paced, accelerated mode. Topics include signed numbers, fractions, decimals, ratios, proportions, percent, 1-variable linear equations, an introduction to 2-variable linear equations, and selected geometry topics. The course is offered as a review and as preparation for further studies in mathematics. This course is equivalent to M 065.

## M 088. Mathematical Literacy. 4 Credits. (4 Lec) F,S

Offered by Gallatin College. Intended for students pursuing majors requiring M 105Q. Develop mathematical literacy through problem solving, critical thinking, writing, and communicating mathematics. Represent and solve relevant, real-world problems using various forms of numbers, equations, and graphs. Topics include proportional reasoning, algebra, geometry, and measurement. Common final.

## M 091. Special Topics. 1-4 Credits.

### M 096. Survey of Algebra. 4 Credits. (4 Lec) F,S,Su

Offered by Gallatin College. PREREQUISITE: M 065 or M 085 or Math Placement Test within the past 12 months. Intended for students pursuing majors requiring the M 121Q track and/or chemistry. This instructor-taught course initiates development in students' ability to organize thought processes and systematically solve problems while preparing students for studies in other courses. Topics include linear equations and inequalities and their graphs, systems of linear equations, exponents, polynomials, factoring, rational expressions, and square roots. This course is equivalent to M 097.

### M 097. Survey of Algebra (Mastery Learning). 4 Credits. (3 Rct, 1 Lab) F,S

Offered by Gallatin College. PREREQUISITE: M 065 or M 085 or Math Placement Test within the past 12 months. Intended for students pursuing majors requiring the M121Q track and/or chemistry. An accelerated lab-based course designed for students who need a review of algebra concepts and are prepared to learn in a self-paced, self-taught mode. Topics include linear equations and inequalities and their graphs, systems of linear equations, exponents, polynomials, factoring, rational expressions, and square roots. This course is equivalent to M 096.

### M 105Q. Contemporary Mathematics (formerly M 145Q, Math for Liberal Arts). 3 Credits. (3 Lec)F,S,Su

PREREQUISITE: M 088, M 096, M 097 or Math Placement Test within the past 12 months. Formerly M 145Q. Designed to give liberal arts students the skills required to understand and interpret quantitative information that they encounter in the news and in their studies, and to make numerically-based decision in their lives. Topics include working with large numbers and units, linear and exponential relations, financial mathematics, and essentials of probability and statistics. Common final.

### M 108. Business Mathematics. 3 Credits. (3 Lec) S

Offered by Gallatin College. PREREQUISITE: M 065. Students of this course will examine the mathematics of business ownership and will demonstrate an understanding of business decisions. Concepts to be covered include cash flow, simple and compound interest, inventory valuation, purchasing discounts, cost markup, business and consumer loans, and analysis of financial statements. Additional topics which may be covered include payroll, depreciation, and bonds and annuities.

### M 111. Technical Mathematics. 3 Credits. (3 Lec.)F,S

Offered by Gallatin College. This course presents basic mathematical topics as they are applied in a trades program. Topics covered include: use of measuring tools, measurement systems, dimensional arithmetic, percent, proportion, applied geometry, basic trigonometry. NOTE: This course is intended for specific programs and does NOT provide sufficient Pre-Algebra material to serve as a prerequisite for students wanting to take additional mathematics.

### M 116. Math for Health Careers. 3 Credits. (3 Lec) S

Offered by Gallatin College. Inductive reasoning; logic; mathematical number systems; linear, quadratic, exponential, and logarithmic functions; graphing; probability; English, Apothecary and Metric systems and conversions; dosage calculations; and dimensional analysis. Offered by Gallatin College.

### M 121Q. College Algebra. 3 Credits. (3 Lec) F,S,Su

PREREQUISITE: M 096, M 097 or Math Placement Test within the past 12 months. Intended for students preparing for precalculus or calculus. Further development of algebraic skills through the study of linear, quadratic, polynomial, exponential, and logarithmic functions. COMMON EXAMS.

### M 132. Numbers & Operations for K-8 Teachers. 3 Credits. (3 Lec) F,S

PREREQUISITES: Level 3 Math Placement Test within the past 12 months, B or better in M 096/097 or C- or better in M 121 (see advisor). The study of number and operations for prospective elementary and middle school teachers, including whole numbers, decimals, fractions, percents, integers, operations, numeration systems, and problem solving. COMMON FINAL ONLY.

### M 133Q. Geometry & Measure K-8 Teachers. 3 Credits. (3 Lec) F,S

PREREQUISITE: A grade of C or better in M 132. The study of geometry and geometric measurement for prospective elementary and middle school teachers, including synthetic, transformational, and coordinate geometry, constructions, congruence and similarity, 2-dimensional and 3-dimensional measurement, and problem solving. COMMON FINAL ONLY.

### M 147Q. Language of Mathematics. 3 Credits. (3 Lec) S

PREREQUISITE: M 088, M 096, M 097 or Math Placement Test within the past 12 months. Reading comprehension and writing skills in the language of mathematics; vocabulary, grammar, syntax and logic; emphasis on understanding, expressing, proving, and thinking mathematical thoughts.

### M 149Q. Secrets of the Infinite. 3 Credits. (2 Lec, 1 Lab) F,S

PREREQUISITE: M 088, M 096, M 097 or Math Placement Test within the past 12 months. Intriguing problems, puzzles, and paradoxes studied from an historical perspective. Hands-on thought experiments follow mathematical ideas as they evolved from ancient beginnings into their modern contexts. Topics vary by semester.

### M 151Q. Precalculus. 4 Credits. (4 Lec) F,S,Su

PREREQUISITE: M 121Q or Math Placement Test within the past 12 months. Functions, graphs, and the use symbols for expressing mathematical thoughts. Polynomials, rational, exponential, logarithmic, and trigonometric functions. COMMON EXAMS.

### M 161Q. Survey of Calculus. 4 Credits. (4 Lec) F,S,Su

PREREQUISITE: M 121Q or Math Placement Test within the past 12 months. A survey of basic calculus including limits, differentiation, and integration with applications to business, biology, and social science problems. COMMON FINAL ONLY.

### M 165Q. Calculus for Technology I. 3 Credits. (3 Lec) F,S

PREREQUISITE: M 151Q or Math Placement Test within the past 12 months. Calculus with emphasis on problems of interest to engineering technologists. Includes analytic geometry, differentiation, and introduction to integration. COMMON FINAL ONLY.

### M 166Q. Calculus for Technology II. 3 Credits. (3 Lec) F,S

PREREQUISITE: M 165Q or M 171Q. Calculus with emphasis on problems of interest to engineering technologists. Includes integration, infinite series, and differential equations. COMMON FINAL ONLY.

### M 171Q. Calculus I. 4 Credits. (4 Lec) F,S,Su

PREREQUISITE: M 151Q or Math Placement Test within the past 12 months. Functions, elementary transcendental functions, limits and continuity, differentiation, applications of the derivative, curve sketching, and integration theory. COMMON EXAMS.

### M 172Q. Calculus II. 4 Credits. (4 Lec) F,S,Su

PREREQUISITE: M 171Q. Methods of integration, applications of the integral, infinite sequences and series including Taylor series, parametric and polar equations. COMMON EXAMS.

### M 181Q. Honors Calculus I. 4 Credits. (4 Lec) F

PREREQUISITE: M 151Q with an "A" grade, 700 on the SAT Math exam, 31 on the ACT Math exam, 4 on an AP Calculus exam, or consent of the instructor. Honors section of M 171Q. Topic coverage parallels M 171Q but with a greater emphasis on theory and more difficult problems.

### M 182Q. Honors Calculus II. 4 Credits. (4 Lec) S

PREREQUISITE: M 171Q with an "A" grade or M 181Q with a "B" grade. Honors section of M 172Q. Topic coverage parallels M 172Q but with a greater emphasis on theory and more difficult problems.

**M 221. Introduction to Linear Algebra. 3 Credits.** (3 Lec) F,S,Su  
 PREREQUISITE: M 166Q or M 172Q. Matrix algebra, systems of linear equations, determinants, vector algebra and geometry in Euclidean 3-space, eigenvalues, eigenvectors.

**M 234. Higher Math for K-8 Teachers. 3 Credits.** (3 Lec) F,S  
 PREREQUISITES: A grade of C or better in both M 132 and M 133Q. The study of algebra, number theory, probability and statistics for prospective elementary and middle school teachers, including proportional reasoning, functions, elementary number theory, statistical modeling and inference, and elementary probability theory.

**M 242. Methods of Proof. 3 Credits.** (3 Lec) F,S  
 PREREQUISITE: M 172Q. Reasoning and communication in mathematics, including logic, generalization, existence, definition, proof, and the language of mathematics. Topics include functions, relations, set theory, recursion, algebra, number theory, and other areas of mathematics.

**M 273Q. Multivariable Calculus. 4 Credits.** (4 Lec) F,S,Su  
 PREREQUISITE: M 172Q. Topics in two and three dimensional geometry. Manipulation and application of vectors. Functions of several variables, contour maps, graphs, partial derivatives, gradients, double and triple integration, vector fields, line integrals, surface integrals, Green's Theorem, Stokes' Theorem, the Divergence Theorem. COMMON FINAL ONLY.

**M 274. Introduction to Differential Equation. 4 Credits.** (4 Lec) F,S,Su  
 PREREQUISITE: M 172Q. An introduction to qualitative, quantitative, and numerical methods for ordinary differential equations. Topics include modeling via differential equations, linear and nonlinear first order differential equations and systems, elementary phase plane analysis, forced oscillations, and Laplace transform techniques. COMMON FINAL ONLY.

**M 283Q. Honors Multivariable Calculus. 4 Credits.** (4 Lec) F  
 PREREQUISITE: M 182Q with a 'B' grade, M 172Q with an 'A' grade, AP Calculus BC exam with a 5, or consent of the instructor. Honors section of M 273Q. Topic coverage parallels M 273Q but with a greater emphasis on theory and more difficult problem solving.

**M 284. Honors Introduction to Differential Equations. 4 Credits.** (4 Lec) S  
 PREREQUISITE: M 283Q with a 'B' grade, M 273Q with an 'A' grade, or consent of the instructor. Honors section of M 274. Topic coverage parallels M 274 but with a greater emphasis on theory and more difficult problem solving.

**M 290R. Undergraduate Research. 1-8 Credits.** (1-8 Ind; 8 cr max) F,S,Su  
 PREREQUISITE: Consent of the department head. Directed undergraduate research. Course will address responsible conduct of research.

**M 291. Special Topics. 1-4 Credits.** (1-4 Lec; 12 cr max) On Demand  
 PREREQUISITE: None required but some may be determined necessary. Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

**M 328. Higher Math for Sec Teachers. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 242. Concepts, processes, and proof relevant to school mathematics, including number theory, abstract algebra, combinatorics and probability; a focus on standards-based content for teachers in secondary schools.

**M 329. Modern Geometry. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 242. A study of Euclidean and non-Euclidean geometries, chosen from; hyperbolic, spherical, projective, finite, transformational, and fractal geometries; computer tools for geometry; a focus on standards-based content for teachers in secondary schools.

**M 330. History of Mathematics. 3 Credits.** (3 Lec) F alternate years, to be offered even years.  
 PREREQUISITE: M 273Q and M 274 or consent of instructor. Topics will be selected from the entire span of history from Egyptian, Babylonian, and Greek times through the 20th century. The course may focus on milestones that lead to the development of modern mathematics as well as the contributions of great mathematicians from ancient times until today. Some ideas will require mathematical sophistication at the upper division level.

**M 333. Linear Algebra. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 221. Vector spaces, subspaces, bases, and dimension. Linear transformations, representation by matrices, nullity, rank, isomorphism. Eigenvalues, eigenvectors, and diagonalization. Inner products, adjoints, unitary, and orthogonal transformations. Jordan form and minimal polynomials.

**M 348. Techniques of Applied Math I. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 273Q and M 274. An introduction to advanced analytical techniques frequently used by scientists and engineers to study ordinary differential equations and two-point boundary value problems. Topics include series solution techniques, method of Frobenius, Laplace transforms, Fourier series, and boundary value problems.

**M 349. Techniques of Applied Mathematics II. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 348. Science and engineering majors often encounter partial differential equations in the study of heat flow, vibrations, electric circuits, and similar areas. Topics include Sturm-Liouville theory, partial differential equations boundary value problems, and Laplace Transform methods.

**M 383. Introduction to Analysis I. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 273Q and either M 242, M 333, or consent of instructor. A rigorous development of calculus with formal proofs. Functions, sequences, limits, continuity, differentiation, and integration.

**M 384. Introduction to Analysis II. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 383. A rigorous development of multivariate calculus. Differentiable functions, inversion theorem, multiple integrals, line and surface integrals, infinite series.

**M 386R. Software Applications in Mathematics. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 221, M 273Q, and M 274. An introduction to modern mathematical and scientific computing. Software such as MAPLE and MATLAB will be used to explore, solve, and visualize solutions of standard mathematical problems as well as simple models of various physical and/or biological systems.

**M 419. Ratio and Proportion in School Mathematics. 3 Credits.** (3 Lec) Su alternate years, to be offered odd years.  
 PREREQUISITE: For undergraduate credit: M 242 or M 234 and 3 credits from the elementary math option. For graduate credit: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Develop knowledge of ratio and proportion necessary to teach standards-based school mathematics. Connect ratio, rate, and proportion to elementary, middle, and high school topics. Explore use of manipulative materials and technologies, and discuss related pedagogical issues and national standards.

**M 420. Geometry, Measurement, and Data in the Middle Grades. 3 Credits.** (3 Lec)  
 Alternate Even Years. PREREQUISITE: A grade of C or better in M 234, or M 242, and junior standing. Develop content knowledge necessary to teach standards-based middle school mathematics. Investigate the underlying conceptual structure of topics in geometry, measurement and data analysis appropriate to middle school. Explore the use of manipulative materials and technologies, and discuss related pedagogical issues and national standards.

**M 424. Algebraic Thinking and Number Sense in the Middle Grades. 3 Credits.** (3 Lec) F  
 to be offered odd years . PREREQUISITE: A grade of C or better in M 234 or M 242, and junior standing. Develop algebraic knowledge necessary to teach standards-based middle school mathematics. Investigate the underlying conceptual structure of topics in algebra and number appropriate to middle school. Explore the use of manipulative materials and technologies, and discuss related pedagogical issues and national standards.

**M 428. Mathematical Modeling for Teachers. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 242, M 221 and STAT 217Q. Senior capstone course. Applications of the modeling process in key areas of mathematics and statistics. Simulation and other activities, use of relevant technology, modeling in the secondary curricula, and the classroom assessment of modeling activities. Emphasis on technology and authentic applications using pre-college mathematics.

**M 430. Mathematical Biology. 3 Credits.** (3 Lec) S  
 PREREQUISITES: M 273Q and M 274 or consent of the instructor. Mathematical modeling of basic biological processes in ecology, physiology, neuroscience, epidemiology and molecular biology using difference equations, differential equations, and partial differential equations.

**M 431. Abstract Algebra I. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 333. Senior capstone course. The integers, integers modulo  $n$ , the Euclidean algorithm. Groups, subgroups, normal subgroups, quotient groups, homomorphism and isomorphism theorems, and abelian groups. Rings, ideals, homomorphism and isomorphism theorems. Integral domains, fields, and fields of quotients.

**M 441. Numerical Linear Algebra & Optimization. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 221 and M 273Q. Numerical solution of nonlinear equations. Numerical solutions of linear systems and eigenvalue problems. Least squares, data smoothing, and optimization techniques.

**M 442. Numerical Solution of Differential Equations. 3 Credits.** (3 Lec) S

PREREQUISITE: M 221 and M 274. Senior capstone course. Numerical integration, numerical solutions of initial and boundary value problems in ordinary differential equations. Numerical solutions of partial differential equations.

**M 450. Applied Mathematics I. 3 Credits.** (3 Lec) F alternate years, to be offered odd years.

PREREQUISITE: M 273Q and M 274. An introduction to modern methods in applied mathematics. Topics include introductions to dimensional analysis and scaling, perturbation and WKB methods, boundary layers, calculus of variations, stability, and bifurcation analysis.

**M 451. Applied Mathematics II. 3 Credits.** (3 Lec) S alternate years, to be offered even years.

PREREQUISITE: M 450. This is the second semester of a course that introduces modern methods in applied mathematics. Topics involve methods for linear and nonlinear partial differential equations, including introductions to Green's functions, Fourier analysis, shock waves, conservation laws, maximum and minimum principles, and integral equations.

**M 454. Introduction of Dynamical Systems I. 3 Credits.** (3 Lec) F alternate years, to be offered even years.

PREREQUISITE: M 273Q and M 274. Existence and uniqueness of solutions to ordinary differential equations, linearization, phase portraits, stability theory, and the analysis of specific examples.

**M 455. Introduction to Dynamical Systems II. 3 Credits.** (3 Lec) S alternate years, to be offered odd years.

PREREQUISITE: M 454. Gradient systems, Poincare'-Bendixson theory, Poincare' maps, structural stability and chaotic systems.

**M 472. Introduction to Complex Analysis. 3 Credits.** (3 Lec) S

PREREQUISITE: M 273Q and M 274. An introduction to the techniques of complex analysis that are frequently used by scientists and engineers. Topics include complex numbers, analytic functions, Taylor and Laurent expansions, Cauchy's theorem, and evaluation of integrals by residues.

**M 476. Introduction to Topology. 3 Credits.** (3 Lec) F

Alternate Odd Years PREREQUISITES: M 221 and M 242 or consent of instructor. Provides an intuitive and rigorous introduction to this important and broad-ranging discipline of modern mathematics. Students will learn to recognize those properties which are topological, i.e., stable under small perturbation. Course participants will compute and see the utility of various topological invariants which arise in a variety of fields from data science, to particle physics, to advanced mathematics.

**M 490R. Undergraduate Research. 1-6 Credits.** (1-6 Ind; 12 cr max) F,S,Su

PREREQUISITE: Junior standing in mathematics and consent of department head. Directed undergraduate research which may culminate in a research paper, journal article, or undergraduate thesis. Course will address responsible conduct of research. May be repeated.

**M 491. Special Topics. 1-4 Credits.** (1-4 Lec; 12 cr max) On Demand

PREREQUISITE: Course prerequisites as determined for each offering. Courses not required in any curriculum for which there is a particular one-time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

**M 492. Independent Study. 1-3 Credits.** (1-3 Ind; 6 cr max) F,S,Su

PREREQUISITE: Junior standing, consent of instructor, and approval of department head. Directed research and study on an individual basis.

**M 494. Seminar. 1 Credit.** (1 Sem; 4 cr max) On Demand

PREREQUISITE: Junior standing and as determined for each offering. Topics offered at the upper division level which are not covered in regular courses. Students participate in preparing and presenting material.

**M 497. Educational Methods: Teaching Fellowship. 1-2 Credits.** (1-3 Ind; 2 cr max) F,S

PREREQUISITE: Junior standing, consent of instructor, and approval of department head. As co-teachers of a Mathematics or Statistics course, students will learn and have the opportunity to practice classroom teaching strategies as well as mentoring skills.

**M 498. Internship. 2-12 Credits.** (2-12 Ind; 12 max) F,S,Su

PREREQUISITE: Junior standing, consent of instructor, and approval of department head. An individualized assignment arranged with an agency, business, or other organization to provide guided experience in the field.

**M 501. Intermediate Probability & Statistics. 3 Credits.** (3 Lec) F

PREREQUISITE: STAT 422 or M 384. Families of probability distributions, distributions of functions of random variables, limiting distributions, order statistics. Cross-listed with STAT 501.

**M 502. Intermediate Mathematical Statistics. 3 Credits.** (3 Lec) S

PREREQUISITE: STAT 501 or M 501. Estimation, likelihood inference, statistical hypothesis tests, sufficient statistics, exponential families, Bayesian statistics. Cross-listed with STAT 502.

**M 503. Advanced Linear Algebra. 3 Credits.** (3 Lec) S

PREREQUISITE: M 333 or consent of instructor. Topics include abstract vector spaces, diagonalization, Schur's Lemma, Jordan canonical form and spectral theory for finite dimensional operators.

**M 504. Abstract Algebra. 3 Credits.** (3 Lec) S

PREREQUISITE: M 431 or consent of instructor. The theory of groups, rings and fields with particular emphasis on finite groups, polynomial rings and fields of characteristic zero.

**M 505. Principles of Mathematical Analysis. 3 Credits.** (3 Lec) F

PREREQUISITE: M 384 or consent of instructor. Principles of analysis in Euclidean spaces and metric spaces.

**M 509. Stochastic Processes. 3 Credits.** (3 Lec) S alternate years, to be offered even years.

PREREQUISITE: STAT 421. Conditional probability theory, discrete and continuous time markov chains including birth and death processes and long run behavior; Poisson processes; queuing systems; system reliability. Cross-listed with STAT 509.

**M 511. General Topology. 3 Credits.** (3 Lec) F

PREREQUISITE: M 384 or consent of instructor. Definition of a topology, relative topology, metric topology, quotient topology, and the product topology. Connectedness, local connectedness, components and path components. Compactness and local compactness, countability and separation axioms, the Urysohn Lemma, metrization and compactification.

**M 512. Geometry & Algebraic Topology. 3 Credits.** (3 Lec) S

PREREQUISITE: M 511 or consent of instructor. Topics in continua theory, topics in dimension theory, covering spaces and the fundamental group, simplicial complexes, topics in homology and cohomology theory.

**M 516. Language of Mathematics for Teachers. 3 Credits.** (3 Lec) Su On Demand.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Features of the language of mathematics, including syntax, vocabulary, and structure. Logic, proof and mathematical communication for high school classrooms.

**M 517. Advanced Mathematical Modeling for Teachers. 3 Credits.** (3 Lec) Su

for two consecutive years; alternates with M 526 PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Focus on the use of modeling to solve real-world problems. Topics include the modeling process, an overview of relevant technology, strategies to engage students in modeling in the secondary classroom, and classroom assessment of modeling activities. Extensive use of mathematics to explore application areas, leading to the construction of original models.

**M 518. Statistics For Teaching. 3 Credits.** (3 Lec) Su

Distance format PREREQUISITE: Graduate standing in mathematics or science education, teaching endorsement in mathematics or science, or consent of instructor. Stochastic concepts including probabilistic underpinnings of statistics, measures of central tendency, variability, correlation, distributions, sampling, and simulation. Exploratory data analysis including experiments, surveys, measures of association and inferential statistics. Discussion of methods for teaching statistics in secondary mathematics and science.

**M 519. Ratio and Proportion in School Mathematics. 3 Credits.** (3 Lec) Su

alternate years, to be offered odd years. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Develop knowledge of ratio and proportion necessary to teach standards-based school mathematics. Connect ratio, rate, and proportion to elementary, middle, and high school topics. Explore use of manipulative materials and technologies, and discuss related pedagogical issues and national standards.

**M 520. Standards-Based Math for Teachers. 3 Credits.** (3 Lec) Su, to be offered odd years.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Study of key content themes and connections in algebra, geometry, probability/data analysis, number, and measurement with a focus on mathematical practices. Exploring, extending, designing, and teaching standards-based classroom activities for middle/high school students and reflecting on student outcomes.

**M 521. Mathematics Learning Theory for Teachers. 3 Credits.** (3 Lec) F alternate years, to be offered even years.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Examine theories of learning as they apply to the mathematics classroom. The course focuses on theories of and research about learning, human development, personality and motivation. The theories and research are used (a) to understand mathematics learning among students of all cultural, linguistic and socioeconomic backgrounds, and (b) to formulate effective teaching and learning strategies.

**M 522. Assessment of Mathematics for Teachers. 3 Credits.** (3 Lec) S On Demand.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Connects assessment theory and models to teachers' practice through classroom observations and hand-on activities. Focus on assessment practices consistent with standards-based mathematics, classroom assessment of student learning, evaluation of mathematics programs and curricula, and standardized testing practices.

**M 523. Number Structure for Teaching. 3 Credits.** (3 Lec) Su, to be offered even years.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Develop the relationship and distinction between the mathematics that underlies the structure of number and the learning and teaching of number structure in schools. Explore representation, abstraction, and basic proof in the context of number and operations. Develop foundations of the real number system and examine relevant research about students' understanding of number.

**M 524. Linear Algebra for Teaching. 3 Credits.** (3 Lec) Su

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Algebraic systems, special matrices, determinants, vector spaces, and linear programming. Includes applications relevant to industry and business and connections to topics in secondary mathematics.

**M 525. Analysis for Teaching. 3 Credits.** (3 Lec) F

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. A study of calculus concepts and processes from graphical, numerical and algebraic perspectives. Extensive use of activities and projects. Modeling and technology are incorporated throughout the course.

**M 526. Discrete Mathematics for Teachers. 3 Credits.** (3 Lec) Su

for two consecutive years; alternates with M 517 PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. A study of classical topics in discrete mathematics, chosen from combinatorics, probability, graph theory, and other areas relevant to secondary mathematics. Emphasis on problem solving and justification.

**M 527. Geometry for Teaching. 3 Credits.** (3 Lec) S

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Explorations of special topics in geometry, such as geometry of transformations including Euclidean motions and similarity, projective geometry, geometric topology and geometry of inversion.

**M 528. Curriculum Design. 3 Credits.** (3 Lec) S alternate years, to be offered even years.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Focuses on the design, implementation, and evaluation of curricula in mathematics. Includes historical changes and trends in mathematics curriculum and an examination of current research.

**M 529. Assessment Models and Issues. 3 Credits.** (3 Lec) F alternate years, to be offered odd years.

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Examines critical K-12 issues including; alignment and interaction of assessment with standards, curriculum, and instruction; role of assessment systems at local, state, and national levels; evaluation of assessment tools and programs; equity considerations in assessment.

**M 533. History of Mathematics for Teachers. 3 Credits.** (3 Lec) F On Demand

Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Focus on the history of mathematics as a context for classroom instruction. Includes the changing nature of mathematics, classical problems, proofs and mathematical processes, and the development of teaching units that incorporate the history of mathematics.

**M 534. Research in Mathematics Education. 3 Credits.** (3 Lec) F, to be offered even years.

PREREQUISITE: Consent of instructor. Examination of quantitative and qualitative research findings and methodology in mathematics education. Review of current trends and literature. Writing for publication and proposals.

**M 535. Technology and Mathematics for Teachers. 3 Credits.** (3 Lec) Su On Demand

PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Calculator, computer and Web-based technologies for K-12 mathematics education. Analysis of the influence of technology on the K-12 mathematics curriculum, instruction, and assessment.

**M 540. Introduction to Calculus on Manifolds. 3 Credits.** (3 Lec)F

PREREQUISITE: M 503 and M 505 or consent of instructor. An introduction to: manifolds and their atlases, fiber bundles, vector fields, tensor fields and differential forms, the exterior and Lie derivatives, Stokes Theorem, and deRham cohomology.

**M 544. Partial Differential Equations I. 3 Credits.** (3 Lec) F alternate years, to be offered odd years.

PREREQUISITE: M 384 and M 451, or consent of instructor. An extended survey of the origins of a large number of scientific and mathematical partial differential equations and an overview of the theoretical techniques which are available to solve them.

**M 545. Partial Differential Equations II. 3 Credits.** (3 Lec) S alternate years, to be offered even years.

PREREQUISITE: M 544 and M 547. Linear partial differential equations and the function spaces and functional analysis which one uses to study them. Topics include: Holder and Sobolev functions, Sobolev and Poincare inequalities, embedding density, semigroup theory for evolution equations.

**M 547. Measure Theory. 3 Credits.** (3 Lec) F

PREREQUISITE: M 384 or M 505. Lebesgue measure, and the Lebesgue integral of functions of a real variable. General measure and integration theory. Lebesgue-Stieltjes integral and product measures.

**M 551. Complex Analysis. 3 Credits.** (3 Lec) S

PREREQUISITE: M 505. Analytic functions and conformal maps, contour integrals, Cauchy's theorem, Cauchy's integral formula, the maximum modulus theorem, harmonic functions, Taylor's theorem and Laurent series. Classification of singularities, the residue theorem and evaluation of definite integrals, Rouché's theorem and the argument principle.

**M 560. Methods of Applied Mathematics I. 3 Credits.** (3 Lec) F alternate years, to be offered even years.

PREREQUISITE: M 451. Finite dimensional vector spaces, spectral theory, Fredholm theorem of matrices, pseudo-inverses. Integral equations, Fredholm alternative and resolvent kernels, singular integral equations. Differential equations and Green's functions, eigenvalue expansions for differential operators.

**M 561. Methods of Applied Mathematics II. 3 Credits.** (3 Lec) S alternate years, to be offered odd years.

PREREQUISITE: M 560. Calculus of variations, Hamilton's principle, asymptotic and perturbation methods, transform techniques and scattering theory. Partial differential equations, Green's functions, separation of variables and transform methods.

**M 570. Individual Problems. 1-3 Credits.** (1-3 Ind; 6 cr max) F,S,Su

PREREQUISITE: Graduate standing, consent of instructor, approval of department head and Dean of Graduate Studies. Directed research and study on an individual basis.

**M 571. Principles of Action Research in Mathematics Education. 2 Credits.** (2 Lec) Su On Demand

PREREQUISITE: Graduate standing in mathematics education and consent of instructor. Prepares practicing mathematics teachers to study a mathematics education problem within their classroom, school or district with supervision by a faculty member. Course topics include how to interpret educational research and literature; design and implement reliable and valid action research; identify worthwhile problems; and formulate questions that can be addressed through action research.

**M 572. Investigating Problems in Mathematics Education. 2 Credits.** (2 Lec) F On Demand.

Distance format. PREREQUISITE: M 571, graduate standing in mathematics education and consent of instructor. With guidance from faculty, students research and investigate a problem related to mathematics education and student success in the context of their classroom, school or district.

**M 575. Professional Paper and Project. 1-4 Credits.** (1-4 Ind; 6 cr max) F,S,Su  
 PREREQUISITE: Graduate standing. A research or professional paper or project dealing with a topic in the field. The topic must have been mutually agreed upon by the student and his or her major advisor and graduate committee.

**M 576. Internship. 2-12 Credits.** (2-12 Ind; unlimited max) F,S,Su  
 PREREQUISITE: Graduate standing, consent of instructor and approval of department head. An individualized assignment arranged with an agency, business or other organization to provide guided experience in the field.

**M 577. Conducting Action Research in Mathematics Education. 3 Credits.** (3 Lec) S  
 Alternate Odd Years. Distance format. PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics and consent of instructor. With guidance from faculty, students conduct action research addressing a problem in the context of their classroom, school or district that influences student success in mathematics. Students work with a faculty advisor to implement an intervention, collect and analyze data resulting, and summarize results. Findings are presented orally to peers and faculty.

**M 580. Special Topics. 4 Credits.** (1-4 Lec, 12 max) On Demand  
 PREREQUISITE: Upper division courses and others as determined for each offering. Courses not required in any curriculum for which there is a particular one time need, or given on a trial basis to determine acceptability and demand before requesting a regular course number.

**M 581. Numerical Solution of Partial Differential Equations I. 3 Credits.** (3 Lec) F  
 PREREQUISITE: M 442. Finite difference and finite element solution techniques for elliptic, parabolic, and hyperbolic partial differential equations, numerical linear algebra.

**M 582. Numerical Solution of Partial Differential Equations II. 3 Credits.** (3 Lec) S  
 PREREQUISITE: M 581. A continuation of topics from M 581.

**M 584. Functional Analysis I. 3 Credits.** (3 Lec) F alternate years, to be offered even years.  
 PREREQUISITE: M 547. Banach spaces, fixed point theorems, Hilbert spaces, the Dirichlet principle, generalized Fourier series, and spectral theory.

**M 585. Functional Analysis II. 3 Credits.** (3 Lec) S alternate years, to be offered odd years.  
 PREREQUISITE: M 584. The Hahn Banach theorem, variational principles, weak convergence, uniform boundedness theorem, the open mapping theorem and the implicit function theorem.

**M 586. Probability Theory. 3 Credits.** (3 Lec) S alternate years, to be offered odd years.  
 PREREQUISITE: M 547. Combinatorial probability and measure theoretic foundations of probability; axioms for probability spaces. Borel-Cantelli Lemmas, weak and strong laws of large numbers, and the central limit problem.

**M 587. Lie Groups. 3 Credits.** (3 Lec) F  
 PREREQUISITES: M 504, M 511. Lie groups, Lie algebras, representation theory.

**M 588. Professional Development. 1-3 Credits.** (1-3 Lec; 3 cr max) On Demand  
 PREREQUISITE: Graduate standing, teaching experience and/or current employment in a school organization, consent of instructor and Dean of Graduate Studies. Courses offered on a one time basis to fulfill professional development needs of in-service educators. A specific focus is given to each course which is appropriately subtitled. May be repeated.

**M 589. Graduate Consultation. 3 Credits.** (3 Ind) F,S,Su  
 PREREQUISITE: Master's standing. This course may be used only by students who have completed all of their course work (and thesis, if on a thesis plan) but who need additional faculty or staff time.

**M 590. Master's Thesis. 1-10 Credits.** (1-10 Ind; max cr unlimited) F,S,Su  
 PREREQUISITE: Master's standing.

**M 591. Topics in Applied Math I. 3 Credits.** (3 Lec) F  
 PREREQUISITE: Graduate standing and consent of instructor. Topics may include numerical solution of linear and nonlinear problems, eigenvalue problems, continuation methods, numerical optimization, computational mechanics, spectral methods, bifurcation theory, invariant manifold theory, index theory, nonlinear analysis, reaction-diffusion equations, nonlinear oscillations, asymptotic methods and perturbation methods.

**M 592. Topics in Applied Math II. 3 Credits.** (3 Lec) S  
 PREREQUISITE: Graduate standing and consent of instructor. Topics may include numerical solution of linear and nonlinear problems, eigenvalue problems, continuation methods, numerical optimization, computational mechanics, spectral methods, bifurcation theory, invariant manifold theory, index theory, nonlinear analysis, reaction-diffusion equations, nonlinear oscillations, asymptotic methods and perturbation methods.

**M 594. Seminar. 1 Credit.** (1 Sem; 6 cr max) F,S,Su  
 PREREQUISITE: Graduate standing or seniors by petition. Course prerequisites as determined for each offering. Topics offered at the graduate level which are not covered in regular courses. Students participate in preparing and presenting discussion material.

**M 595. Dynamical Systems I. 3 Credits.** (3 Lec) F alternate years, to be offered odd years.  
 PREREQUISITE: M 503. Topics in differential equations including existence and uniqueness, continuous dependence on parameters, extendibility, the existence and stability of equilibria and limit cycles and the Poincare-Bendixon theorem.

**M 596. Dynamical Systems II. 3 Credits.** (3 Lec) S alternate years, to be offered even years.  
 PREREQUISITE: M 595. Topics include Hartman's theorem, invariant manifold theory, Smale-Birkhoff theorem, horseshoe chaos, and the Melnikov method. Topics in discrete dynamical systems may also be covered.

**M 597. Topics in Math I. 3 Credits.** (3 Lec) F  
 PREREQUISITE: Graduate standing and consent of instructor. Topics selected from: differential topology, differential geometry and complex dynamics.

**M 598. Topics in Math II. 3 Credits.** (3 Lec) S  
 PREREQUISITE: Graduate standing and consent of instructor. Topics selected from: continuum theory, symbolic dynamics, ergodic theory and low dimensional topology.

**M 689. Doctoral Reading & Research. 3-5 Credits.** (3-5 Ind; 15 cr max) F,S,Su  
 PREREQUISITE: Doctoral standing. This course may be used by doctoral students who are reading research publications in the field in preparation for doctoral thesis research.

**M 690. Doctoral Thesis. 1-10 Credits.** (1-10 Ind; max unlimited) F,S,Su  
 PREREQUISITE: Doctoral standing.

### **Font Notice**

This document should contain certain fonts with restrictive licenses. For this draft, substitutions were made using less legally restrictive fonts. Specifically:

Times was used instead of Adobe Garamond Pro.

The editor may contact Leepfrog for a draft with the correct fonts in place.