M - Mathematics

M 005 Co-Req Support for M 105Q: 1 Credits (1 Lec)
PREREQUISITE: MPLEX Level 2 or higher, ACT 17 or higher, new SAT 460 or 23 or higher, old SAT 420 or higher.
COREQUISITE: Must concurrently enroll in the section of M105 with the matching section number. This co-requisite support course allows students who do not meet the prerequisites of M105Q to enroll in specific sections of M105Q. This course will provide an additional day of instruction and will present additional topics to support student success and understanding in M105Q.

M 019 Co-Requisite Support for M121Q College Algebra: 2 Credits (2 Lec)
PREREQUISITE: MPLEX 30 or ACT 21 or SAT 530 or 26 or old SAT 500 or M 065 A− or A. This course serves as a co-requisite for M121Q (College Algebra). Upon completing this course along with the co-requisite M121Q, students will be prepared to take M151Q or M161Q (depending on major). This course is intended to allow some students placing into developmental math an opportunity to enroll in M121Q while providing the additional time and support associated with developmental courses.

M 063 Foundations of Mathematics: 2 Credits (2 Lec)
This instructor-taught course covers basic concepts relating to whole numbers, integers, fractions, decimals, percent and selected geometry topics. This course is to be taken during the same semester as M090. The course is offered as a review and/or preparation for further studies in Mathematics. Offered by Gallatin College.

M 065 Pre-Algebra: 4 Credits (4 Lec)
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. Common final.

M 066 Pre-Algebra Lab and Study: 1 Credits (1 Other)
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 088 Mathematical Literacy: 4 Credits (4 Lec)
Intended for students pursuing majors requiring M 105Q.

M 090 Introductory Algebra: 4 Credits (4 Lec)
PREREQUISITE: M063 or ACT 17 or ACT 15/16 or HS GPA greater than 3. Offered by Gallatin College. Intended for students pursuing majors requiring the M 121Q track and/or chemistry. This course serves as an introduction to algebra, which includes the study of basic operations with algebraic fractions and polynomials, linear equations and inequalities in one and two variables, systems of linear equations, and linear applications in one and two variables including percent applications.

M 091 Special Topics: 1-4 Credits (1-4 Lec)
Repeatable up to 12 credits.

M 105Q Contemporary Mathematics (formerly M 145Q, Math for Liberal Arts): 3 Credits (3 Lec)
PREREQUISITE: M 088, 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)
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)
PREREQUISITE: Math Placement Test within the past 12 months. 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 120Q College Algebra: 3 Credits (3 Lec)
PREREQUISITE: 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 121Q Precalculus: 4 Credits (4 Lec)
PREREQUISITE: M 120Q or Math Placement Test within the past 12 months, B 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, number systems, and problem solving. COMMON FINAL ONLY

M 122Q College Algebra: 3 Credits (3 Lec)
PREREQUISITE: M 120Q or Math Placement Test within the past 12 months. B 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, number systems, and problem solving. COMMON FINAL ONLY

M 124Q Precalculus: 4 Credits (4 Lec)
PREREQUISITE: M 120Q or Math Placement Test within the past 12 months. Further development of algebraic skills through the study of linear, quadratic, polynomial, exponential, and logarithmic functions. COMMON EXAMS

M 130Q Geometry & Measure K-8 Teachers: 3 Credits (3 Lec)
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 132 Numbers & Operations for K-8 Teachers: 3 Credits (3 Lec)
PREREQUISITE: Level 3 Math Placement Test within the past 12 months, B 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, number systems, and problem solving. COMMON FINAL ONLY

M 133Q Survey of Calculus: 4 Credits (4 Lec)
PREREQUISITE: M 088, 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 134Q Calculus for Technology I: 3 Credits (3 Lec)
PREREQUISITE: M 133Q. The study of the limits of functions, continuity, derivatives, and integrals. Functions, graphs, and the use symbols for expressing mathematical ideas as they evolved from ancient beginnings into their modern contexts. Topics vary by semester.

M 151Q Precalculus: 4 Credits (4 Lec)
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 Calculus for Technology I: 3 Credits (3 Lec)
PREREQUISITE: M 121Q 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.
M 160Q Calculus for Technology II: 3 Credits (3 Lec)
PREREQUISITE: M 160Q or M 171Q. Calculus with emphasis on problems of interest to engineering technologists. Includes integration, infinite series, and differential equations

M 171Q Calculus I: 4 Credits (4 Lec)
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)
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)
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)
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)
PREREQUISITE: M 160Q 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)
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. Department of Mathematical Sciences

M 242 Methods of Proof: 3 Credits (3 Lec)
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 274 Multivariable Calculus: 4 Credits (4 Lec)
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)
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)
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)
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 Other)
PREREQUISITE: Consent of the department head. Directed undergraduate research. Course will address responsible conduct of research. Repeatable up to 8 credits.

M 291 Special Topics: 1-4 Credits (1-4 Lec)
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. Repeatable up to 12 credits.

M 328 Higher Math for Sec. Teachers: 3 Credits (3 Lec)
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)
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)
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)

M 348 Techniques of Applied Math I: 3 Credits (3 Lec)
PREREQUISITE: M 273Q and M 274. An introduction to advanced analytical techniques frequently used by scientists and engineers to study ordinary differential equations and one-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)
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)
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)
M 386R  Software Applications in Mathematics: 3 Credits (3 Lec)  
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)  
PREREQUISITE: A grade of C or better in M 242 or M 234 and junior standing; or, admission to the MAT program. 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)  
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)  
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)  
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)  
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)  
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)  

M 442  Numerical Solution of Differential Equations: 3 Credits (3 Lec)  

M 450  Applied Mathematics I: 3 Credits (3 Lec)  
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)  
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)  
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)  
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)  
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)  
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 Other)  
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. Repeatable up to 12 credits.

M 491  Special Topics: 1-4 Credits (1-4 Lec)  
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. Repeatable up to 12 credits.

M 492  Independent Study: 1-3 Credits (1-3 Other)  
PREREQUISITE: Junior standing, consent of instructor, and approval of department head. Directed research and study on an individual basis. May be repeated. Repeatable up to 6 credits.

M 494  Seminar: 1 Credits (1 Other)  
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. Repeatable up to 4 credits.

M 497  Educational Methods: Teaching Fellowship: 1-3 Credits (1-3 Other)  
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. Repeatable up to 4 credits.

M 498  Internship: 2-12 Credits (2-12 Other)  
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. Repeatable up to 12 credits.
M 501 Intermediate Probability & Statistics: 3 Credits (3 Lec)
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)

M 503 Advanced Linear Algebra: 3 Credits (3 Lec)
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)
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)
PREREQUISITE: M 384 or consent of instructor. Principles of analysis in Euclidean spaces and metric spaces

M 507 Mathematical Optimization: 3 Credits (3 Lec)
PREREQUISITES: M 273, M 441
This course is an introduction to mathematical optimization at the graduate level for mathematics, science, engineering and management majors. It aims to provide an overview of the computational methods for solving linear and nonlinear optimization problems. In particular, the students will learn some of the fundamental optimization algorithms used in practice. Topics include fundamental concepts in optimization, simplex method, duality theory, methods for unconstrained optimization, optimality conditions for constrained problems, and penalty and augmented Lagrangian methods for solving nonlinear constrained problems.

M 508 Mathematics of Machine Learning: 3 Credits (3 Lec)
PREREQUISITES: M 273 and M 441
“Mathematics of Machine Learning” is an introductory graduate level course on mathematical models for pattern recognition and machine learning. The students will become familiar with fundamental concepts such as learning of parametric and non-parametric probability distributions, the curse of dimensionality, correlation analysis and dimensionality reduction, and concepts of decision theory. Advanced machine learning and pattern recognition problems will be covered, including data classification and clustering, regression, kernel methods, artificial neural networks, and Markov-based models such as hidden Markov models and Markov random fields. These methods will be illustrated by practical examples drawn from practical data science problems. Repeatable up to 3 credits.

M 509 Stochastic Processes: 3 Credits (3 Lec)
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)
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)
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 Teaching: 3 Credits (3 Lec)
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 Teaching: 3 Credits (3 Lec)
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)
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)
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 Access and Equity in Mathematics Teaching: 3 Credits (3 Lec)
PREREQUISITE: Graduate standing in mathematics education, teaching endorsement in mathematics, or consent of instructor. Study of the social context of schooling in the U.S. through the lens of access and equity in mathematics education. 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 equity-oriented classroom activities for middle/high school students and reflecting on issues of access, equity, and student outcomes

M 521 Mathematics Learning Theory for Teaching: 3 Credits (3 Lec)
PREREQUISITE: Graduate standing, teaching endorsement in mathematics, or consent of instructor. Examine theories of learning as they apply to the mathematics classroom. The course focuses on theories and research about learning and human development. These are used (a) to understand mathematics learning among students of all cultural, linguistic and socioeconomic backgrounds, and (b) to formulate effective, equitable teaching and learning strategies

M 522 Assessment of Mathematics for Teaching: 3 Credits (3 Lec)
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 and classroom assessment of student learning

M 523 Number Structure for Teaching: 3 Credits (3 Lec)
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)
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)
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. Technology is incorporated throughout the course. Includes connections to topics in secondary mathematics

M 526 Discrete Mathematics for Teaching: 3 Credits (3 Lec)
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)
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. Technology in incorporated throughout the course

M 528 Curriculum Design: 3 Credits (3 Lec)
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)
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 Teaching: 3 Credits (3 Lec)
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)
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 Teaching: 3 Credits (3 Lec)
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)
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 de'Rham cohomology

M 544 Partial Differential Equations I: 3 Credits (3 Lec)
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)
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)
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)
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, Rouche’s theorem and the argument principle

M 560 Methods of Applied Mathematics I: 3 Credits (3 Lec)

M 561 Methods of Applied Mathematics II: 3 Credits (3 Lec)
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 571 Principles of Action Research in Mathematics Education: 2 Credits (2 Lec)
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)
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 Other)
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 Repeatable up to 6 credits.
M 576 Internship: 1-12 Credits (1-12 Other)
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. Repeatable up to 99 credits.

M 577 Conducting Action Research in Mathematics Education: 3 Credits (3 Lec)
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 (4 Lec, 4 Other)
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. Repeatable up to 12 credits.

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

M 584 Functional Analysis I: 3 Credits (3 Lec)
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)
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)

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

M 588 Professional Development: 1-3 Credits (1-3 Lec)
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. Repeatable up to 3 credits.

M 589 Graduate Consultation: 3 Credits (3 Other)
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 Other)
PREREQUISITE: Master’s standing. Repeatable up to 99 credits.

M 591 Topics in Applied Math I: 3 Credits (3 Lec)
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)
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 Credits (1 Other)
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. Repeatable up to 6 credits.

M 595 Dynamical Systems I: 3 Credits (3 Lec)
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)
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: Character Varieties and 3-manifolds: 3 Credits (3 Lec)
PREREQUISITE: Graduate standing or consent of instructor. Topics include the theory of representations of finitely generated groups into matrix groups and applications of this theory to the study of low-dimensional topology. Our primary tools will be SL(2, C) and PSL(2, C) character varieties. Culler-Shalen theory and its applications will be discussed in depth. We will also cover some of the basics of low-dimensional topology along with classical affine and projective algebraic geometry. Computational techniques in algebraic geometry and commutative algebra will be highlighted to encourage experimentation and exploration.

M 598 Topics in Math II: 3 Credits (3 Lec)
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 Other)
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. Repeatable up to 15 credits.

M 690 Doctoral Thesis: 1-10 Credits (1 Other)
PREREQUISITE: Doctoral standing. Repeatable up to 99 credits.