MAE

Mathematics Teacher Preparation

MAE 301: Foundations of Secondary School Mathematics
A re-examination of elements of school mathematics, including topics in algebra, geometry, and elementary functions. Competence in basic secondary-level ideas and techniques are tested.
Prerequisites: MAT 200 and 211; admission to mathematics or applied mathematics secondary teacher preparation program
Corequisite: MAE 311
3 credits

MAE 302: Methods and Materials for Teaching Secondary School Mathematics
The goals of mathematics education, learning theories, mathematics curricula, lesson planning, evaluation and teaching strategies. Lesson plans are drawn up and presented to the group.
Prerequisites: MAE 301 and C or higher in MAE 311
Pre- or Corequisite: MAE 312
3 credits

MAE 311: Introduction to Methods of Teaching Secondary School Mathematics
Aspects of teaching mathematics on the secondary school level, including lesson designs based on the NCTM standards, cooperative learning, and technology in mathematics education. Students observe classes in middle school and high school settings.
Prerequisites: MAT 211; admission to mathematics or applied mathematics secondary teacher preparation program; department consent
Corequisite: MAE 301
3 credits

MAE 312: Micro-Teaching
Twice-weekly supervised classroom experience, tutoring, or working with small groups of students as a teacher's aide.
Prerequisite: C or higher in MAE 311
Pre- or Corequisite: MAE 302
2 credits

MAE 330: Technology in Mathematics Education
Introduces students in the secondary mathematics teacher preparation program to techniques and requirements for effective use of technology in the mathematics classroom. Emphasis on projects. Use of graphing calculators and computer software such as Geometer’s Sketchpad.
Prerequisites: MAE 301 and 311
3 credits

MAE 412: Issues in Teaching and Learning in Collegiate Mathematics
Investigation of the issues involved in the teaching and learning of introductory collegiate mathematics. A supervised teaching internship of undergraduate mathematics accompanies this seminar.
Prerequisite: MAE 302
4 credits

MAE 447: Directed Readings in Mathematics Education
Tutorial studies in recent advances in mathematics education.
Pre- or Corequisite: MAE 312
1 credit

MAE 451: Supervised Teaching - Middle School Level Grades 7-9
Intensive supervised teaching in secondary schools. Students work in the school under the supervision of an experienced teacher.
Prerequisites: MAE 312; MAT 312, 319 and 360; AMS 310; permission of director of mathematics teacher education program
Corequisites: MAE 452 and 454
6 credits, S/U grading

MAE 452: Supervised Teaching - High School Grades 10-12
Intensive supervised teaching in secondary schools. Students work in the school under the supervision of an experienced teacher.
Prerequisites: MAE 312; MAT 312, 319 and 360; AMS 310; permission of director of mathematics teacher education program
Corequisites: MAE 451 and 454
6 credits, S/U grading

MAE 454: Student Teaching Seminar
Weekly discussions of teaching techniques and experiences, learning theory, curriculum content, and classroom problems.
Corequisites: MAE 451 and 452
3 credits

Mathematics Proficiency

MAP 101: Fundamentals of Arithmetic and Algebra
Arithmetic: fractions, decimals, and percent. Algebra: signed numbers, monomials, linear equations in one unknown, and word problems. This course is intended for students who have never studied algebra. Does not satisfy the entry skill in mathematics requirement or the D.E.C. category C requirement. Students who have otherwise satisfied D.E.C. category C may not register for this course. Overqualified students as determined by a placement test may be deregistered and directed to transfer to another course. Does not count toward graduation. A through C/Unsatisfactory grading only. The Pass/No Credit option may not be used.
3 credits

MAP 103: Proficiency Algebra
An intensive review of high school algebra as preparation for calculus and other mathematics. Facility with exponents, basic graphing, solving linear and quadratic equations in one variable, solving linear systems in two variables, polynomials, factorization of algebraic expressions, binomial theorem, and inequalities. Algebraic manipulations, analytic geometry of lines. Does not count toward graduation. A through C/Unsatisfactory grading only. The Pass/No Credit option may not be used.
Prerequisite: Level 2 on the mathematics placement examination or MAP 101
3 credits

MAT

Mathematics

MAT 118 - C: Mathematical Thinking
Development of quantitative thinking and problem solving abilities through a selection of mathematical topics: logic and reasoning; numbers, functions, and modeling; combinatorics and probability; growth and change. Other topics may include geometry, statistics, game theory, and graph theory. Through their engagement in problem solving, students develop an appreciation of the intellectual scope of mathematics and its connections with other disciplines.
Prerequisite: C or better in MAP 103 or level 2+ or higher on the mathematics placement examination
(Prerequisite must be met within one year of beginning this course.)
3 credits
**MAT 122 - C: Overview of Calculus with Applications**
The basics of calculus in a self-contained, one-semester course. Properties and applications of polynomial, exponential, and logarithmic functions. Derivatives: slopes, rates of change, optimization, integrals, area, cumulative change, and average. The fundamental theorem of calculus. Emphasis on modeling examples from economics. Students who subsequently wish to enroll in MAT 125 or 131 will be required to take MAT 130 as a pre-or corequisite to either course or to score level 4 on the mathematics placement examination before taking either course.

Prerequisite: C or better in MAP 103 or level 3 on the mathematics placement exam
(Prerequisite must be met within one year prior to beginning the course.)
3 credits

**MAT 123 - C: Introduction to Calculus**

Prerequisite: C or better in MAP 103 or level 3 on the mathematics placement exam
(Prerequisite must be met within one year prior to beginning the course.)
3 credits

**MAT 125 - C: Calculus A**
Differential calculus, emphasizing conceptual understanding, computations and applications, for students who have the necessary background from 12th-year high school mathematics. Differentiation of elementary algebraic, trigonometric, exponential and logarithmic functions; graphing; modeling; and maximization. May not be taken for credit in addition to MAT 131 or 141 or AMS 151.

Prerequisite: C or higher in MAT 123; level 4 on the mathematics placement examination; or MAT 122 and coregistration in MAT 130
3 credits

**MAT 126 - C: Calculus B**
A continuation of MAT 125, covering integral calculus: the fundamental theorem, symbolic and numeric methods of integration, area under a curve, volume, applications such as work and probability, complex numbers. May not be taken for credit in addition to MAT 142 or AMS 161.

Prerequisite: C or higher in MAT 125 or 131 or 141 or AMS 151 or level 6 on the mathematics placement examination
3 credits

**MAT 127 - C: Calculus C**
A continuation of MAT 126, covering: improper integrals and l'Hopital's rule, sequences, series, Taylor series, differential equations and modeling. May not be taken for credit in addition to MAT 132 or 142 or AMS 161.

Prerequisite: C or higher in MAT 126 or level 8 on the mathematics placement examination
3 credits

**MAT 129: Introduction to Integration**
This course covers the material that is in MAT131 and not MAT125: The Riemann integral and the Fundamental Theorem of Calculus. This course serves as a bridge for students who took MAT125 but are ready to handle the faster pace of MAT132. Students must have a solid understanding of differentiation, which is covered by MAT125. Not for credit in addition to any of MAT126, MAT131, MAT141, or AMS151. Offered in winter session only.

Prerequisites: B or better in MAT 125 or Math placement level 6
1 credit

**MAT 130: Functions**
Inverse functions, exponential and logarithmic functions, radian measure of angles and trigonometric functions. Open to prospective students in engineering, physical sciences, and mathematics who need to bridge the gap between MAT 122 and 125 or MAT 131 or AMS 151. May not be taken for credit in addition to MAT 123.

Advisory Prerequisite: C or higher in MAT 122
Advisory Corequisite: MAT 125 or 131 or AMS 151
1 credit

**MAT 131 - C: Calculus I**
The differential calculus and integral calculus, emphasizing conceptual understanding, computations and applications, for students who have the necessary background from 12th-year high school mathematics. Differentiation of elementary algebraic; trigonometric, exponential, and logarithmic functions; graphing; modelling and maximization; the Riemann integral; and the fundamental theorem. May not be taken for credit in addition to MAT 125 or 141 or AMS 151.

Prerequisite: B or higher in MAT 123, or level 5 on the mathematics placement examination, or B or higher in MAT 122 and coregistration in MAT 130
4 credits

**MAT 132 - C: Calculus II**
A continuation of MAT 131, covering symbolic and numeric methods of integration; area under a curve; volume; applications such as work and probability; improper integrals and l'Hopital's rule; complex numbers; sequences; series; Taylor series; differential equations; and modelling. May not be taken for credit in addition to MAT 127 or 142 or AMS 161.

Prerequisite: C or higher in AMS 151 or MAT 131 or 141, or level 7 on the mathematics placement examination
4 credits

**MAT 141 - C: Honors Calculus I**
The topics of MAT 131 treated with additional attention to the underlying theory as a means of understanding why the processes of calculus work. May not be taken for credit in addition to MAT 125 or 131.

Prerequisite: Level 5 on the mathematics placement examination; priority given to students in the University's honors programs
4 credits

**MAT 142: Honors Calculus II**
A continuation of MAT 141 in the same spirit, covering the topics of MAT 132. May not be taken for credit in addition to MAT 126 or 127 or 132 or AMS 161.

Prerequisite: C or higher in MAT 141, or B or higher in MAT 131 or AMS 151, or level 7 on the mathematics placement examination
4 credits

**MAT 160: Mathematical Problems and Games**
Intended for students interested in sharpening their problem-solving skills and in developing their ability to express mathematical ideas.

1 credit, S/U grading

**MAT 171 - C: Accelerated Single-Variable Calculus**
A single semester, honors-level, course which reviews the material in MAT 131 in a few weeks, then concentrates on the topics covered in MAT 132, with additional attention paid to the underlying theory. Primarily intended for students who have had calculus in high school.

May not be taken for credit in addition to MAT 126 or 127 or 132 or 142 or AMS 161.
Prerequisites: Level 5 on the AB Calculus AP exam, Level 3 on the BC Calculus exam, A or A- in MAT 131 or AMS 151, MAT 141, or level 7 on the mathematics placement exam. Priority given to students in the University's honors programs.

4 credits

MAT 200: Logic, Language and Proof
A basic course in the logic of mathematics, the construction of proofs and the writing of proofs. The mathematical content is primarily set theory, combinatorics and Euclidean geometry. There is considerable focus on writing.
Prerequisites: C or higher in MAT 203, 205 or AMS 261, and in MAT 211 or AMS 210; or A- or higher in MAT 125, 131, 141 or AMS 151; or B- or higher average in MAT 125/126/127, 131/132, 141/142, 171 or AMS 151/161; or permission of instructor
3 credits

MAT 203: Calculus III with Applications
Vector algebra in two and three dimensions, multivariate differential and integral calculus, optimization, vector calculus including the theorems of Green, Gauss, and Stokes. Applications to economics, engineering, and all sciences, with emphasis on numerical and graphical solutions; use of graphing calculators or computers. May not be taken for credit in addition to AMS 261 or MAT 205.
Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination
4 credits

MAT 205: Calculus III
Vector algebra, multivariate differential and integral calculus, divergence and curl, line and surface integrals, theorems of Green, Gauss, and Stokes. More theoretical than MAT 203 with applications to the physical sciences. Not for credit in addition to AMS 261 or MAT 203.
Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination
4 credits

MAT 211: Introduction to Linear Algebra
Introduction to the theory of linear algebra with some applications; vectors, vector spaces, bases and dimension, applications to geometry, linear transformations and rank, eigenvalues and eigenvectors, determinants and inner products. May not be taken for credit in addition to AMS 210.

Prerequisite: C or higher in AMS 151 or MAT 131 or 141 or coregistration in MAT 126 or level 7 on the mathematics placement examination
3 credits

MAT 260: Problem Solving in Mathematics
Students actively solve challenging problems in plane geometry, basic number theory, and calculus, and write precise arguments. Relevant preparation for problem-solving is provided in the course.
Prerequisite: MAT 203 or 205 or AMS 261, or B or higher in MAT 127 or 132 or 142 or AMS 151
1 credit

MAT 303: Calculus IV with Applications
Homogeneous and inhomogeneous linear differential equations; systems of linear differential equations; series solutions; Laplace transforms; Fourier series. Applications to economics, engineering, and all sciences with emphasis on numerical and graphical solutions; use of computers. May not be taken for credit in addition to AMS 361 or MAT 305.
Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination
4 credits

MAT 305: Calculus IV
Linear versus nonlinear equations and their numerical solutions, existence and uniqueness, Duhamel's principle for linear equations, series solutions, systems. Fourier series; comparison of separation of variables with integral formulas. More theoretical than MAT 303. Applications to the physical sciences. May not be taken for credit in addition to MAT 303 or AMS 361.
Prerequisite: C or higher in MAT 127 or 132 or 142 or AMS 161 or level 9 on the mathematics placement examination
4 credits

MAT 307: Multivariable Calculus with Linear Algebra
Introduction to linear algebra: vectors, matrices, systems of linear equations, bases and dimension, dot product, determinants. Multivariate differential and integral calculus, divergence and curl, line and surface integrals, theorems of Green, Gauss, and Stokes. More theoretical and intensive than MAT 203, this course is primarily intended for math majors. Together with MAT 308, it forms a 2-semester sequence covering the same material as the 3-semester sequence of MAT 205, MAT 211
and MAT 305. May not be taken for credit in addition to MAT 203, MAT 205 or AMS 261.
Prerequisite: MAT 127 or MAT 132
4 credits

MAT 308: Differential Equations with Linear Algebra
Linear algebra: determinants, eigenvalues and eigenvectors, diagonalization. Differential equations; existence and uniqueness of solutions. First- and second-order equations; linear versus nonlinear equations. Systems of linear equations. Laplace transform. Applications to physics. More theoretical and intensive than MAT 303, this course is primarily intended for math majors. Together with MAT 307, it forms a 2-semester sequence covering the same material as the 3-semester sequence of MAT 205, MAT 211 and MAT 305. May not be taken for credit in addition to MAT 303, MAT 305 or AMS 361.
Prerequisite: MAT 307 or MAT 205 and MAT 211
4 credits

MAT 310: Linear Algebra
Finite dimensional vector spaces, linear maps, dual spaces, bilinear functions, inner products. Additional topics such as canonical forms, multilinear algebra, numerical linear algebra.
Prerequisites: C or higher in MAT 211 or 305 or AMS 210; C or higher in MAT 200 or permission of instructor
4 credits

MAT 311: Number Theory
Congruences, quadratic residues, quadratic forms, continued fractions, Diophantine equations, number- theoretical functions, and properties of prime numbers.
Prerequisites: C or higher in MAT 312 or 313 or 318; C or higher in MAT 200 or permission of instructor
3 credits

MAT 312: Applied Algebra
Topics in algebra: groups, informal set theory, relations, homomorphisms. Applications: error correcting codes, Burnside's theorem, computational complexity, Chinese remainder theorem. This course is offered as both AMS 351 and MAT 312.
Prerequisite: C or higher in AMS 210 or MAT 211
Advisory Prerequisite: MAT 200 or CSE 113
3 credits

MAT 313: Abstract Algebra
Groups and rings together with their homomorphisms and quotient structures. Unique factorization, polynomials, and fields.

**Prerequisites:** C or higher in MAT 310 or 312 or 318; C or higher in MAT 200 or permission of instructor

3 credits

**MAT 316: Invitation to Modern Mathematics**

Mathematical reasoning and the process of mathematical research. The power and range of modern mathematics are discussed in detail through a few key theorems in algebra, analysis, geometry, and topology together with some applications.

**Prerequisites:** MAT 211 or AMS 210; MAT 203 or 205 or AMS 261; MAT 200 or permission of instructor

3 credits

**MAT 319: Foundations of Analysis**

A careful study of the theory underlying topics in one-variable calculus, with an emphasis on those topics arising in high school calculus. The real number system. Limits of functions and sequences. Differentiation, integration, and the fundamental theorem. Infinite series.

**Prerequisites:** C or higher in MAT 200 or permission of instructor; C or higher in one of the following: MAT 203, 205, AMS 261, or A- or higher in MAT 127, 132, 142, or AMS 161

4 credits

**MAT 320: Introduction to Analysis**


**Prerequisites:** C or higher in MAT 200 or permission of instructor; C or higher in one of the following: MAT 203, 205, 211, AMS 261, or A- or higher in MAT 127, 132, 142, or AMS 161

4 credits

**MAT 322: Analysis in Several Dimensions**


**Prerequisites:** C or higher in MAT 203, 205, or AMS 261; C or higher in MAT 211 or AMS 210; B or higher in MAT 320

Advisory Pre- or Corequisite: MAT 310

3 credits

**MAT 324: Real Analysis**


**Prerequisites:** C or higher in MAT 203 or 205 or AMS 261; B or higher in MAT 320

3 credits

**MAT 331: Computer-Assisted Mathematical Problem Solving**

Exploration of the use of the computer as a tool to gain insight into complex mathematical problems through a project-oriented approach. Students learn both the relevant mathematical concepts and ways that the computer can be used (and sometimes misused) to understand them. The particular problems may vary by semester; past topics have included cryptography, fractals and recursion, modeling the flight of a glider, curve fitting, the Brachistochrone, and computer graphics. No previous experience with computers is required.

**Prerequisite:** C or higher in MAT 203 or 205 or AMS 261

3 credits

**MAT 336 - H: History of Mathematics**

A survey of the history of mathematics from the beginnings through the 19th century, with special attention to primary sources and to the interactions between culture and mathematics. Emphasis on topics germane to the high school curriculum. Mesopotamian, Egyptian, and Greek mathematics; non-European mathematics; early Renaissance mathematics; the birth and flowering of calculus; the beginnings of probability theory; and the origin of non-euclidean geometries and the modern concept of number.

**Prerequisite:** MAT 200 or AMS 301

3 credits

**MAT 341: Applied Real Analysis**

Partial differential equations of mathematical physics: the heat, wave, and Laplace equations. Solutions by techniques such as separation of variables using orthogonal functions (e.g., Fourier series, Bessel functions, Legendre polynomials). D’Alembert solution of the wave equation.

**Prerequisites:** C or higher in the following: MAT 203 or 205 or AMS 261; MAT 303 or 305 or AMS 361

Advisory Prerequisite: MAT 200

3 credits

**MAT 342: Applied Complex Analysis**

Functions of a complex variable, calculus of residues including evaluation of real integrals, power and Laurent series, conformal mappings and applications, Laplace and Cauchy-Riemann equations, the Dirichlet and Neumann problems, and the Laplace and Hilbert transforms and their applications to ordinary and partial differential equations.

**Prerequisites:** C or higher in the following: MAT 203 or 205 or AMS 261; MAT 303 or 305 or AMS 361

Advisory Prerequisite: MAT 200

3 credits

**MAT 351: Differential Equations: Dynamics and Chaos**

A study of the long-term behavior of solutions to ordinary differential equations or of iterated mappings, emphasizing the distinction between stability on the one hand and sensitive dependence and chaotic behavior on the other. The course describes examples of chaotic behavior and of fractal attractors, and develops some mathematical tools for understanding them.

**Prerequisites:** C or higher in the following: MAT 203 or 205 or AMS 261; MAT 303 or 305 or AMS 361; MAT 200 or permission of instructor

3 credits

**MAT 360: Geometric Structures**

Formal geometries and models. Topics selected from projective, affine, Euclidean, and non-Euclidean geometries.

**Pre- or Corequisites:** C or higher in the following: MAT 203 or 205 or AMS 261; MAT 211 or AMS 210; MAT 200 or permission of instructor

3 credits

**MAT 362: Differential Geometry of Surfaces**

The local and global geometry of surfaces: geodesics, parallel transport, curvature, isometries, the Gauss map, the Gauss-Bonnet theorem.

**Prerequisite:** C or higher in MAT 319 or 320 or 364

3 credits

**MAT 364: Topology and Geometry**

A broadly based introduction to topology and geometry, the mathematical theories of shape, form, and rigid structure. Topics include intuitive knot theory, lattices and tilings, non-Euclidean geometry, smooth curves and surfaces in Euclidean 3-space, open sets and continuity, combinatorial and algebraic...
invariants of spaces, higher dimensional spaces.

**Prerequisites:** MAT 203 or 205 or AMS 261
Advisory Prerequisite: MAT 319 or 320
3 credits

**MAT 371: Logic**
A survey of the logical foundations of mathematics: development of propositional calculus and quantification theory, the notions of a proof and of a model, the completeness theorem, Goedel's incompleteness theorem. This course is offered as both CSE 371 and MAT 371.

**Prerequisite:** CSE 150 or CSE 215 or MAT 200
3 credits

**MAT 373: Analysis of Algorithms**
Mathematical analysis of a variety of computer algorithms including searching, sorting, matrix multiplication, fast Fourier transform, and graph algorithms. Time and space complexity. Upper-bound, lower-bound, and average-case analysis. Introduction to NP completeness. Some machine computation is required for the implementation and comparison of algorithms. This course is offered as CSE 373 and MAT 373.

**Prerequisites:** MAT 211 or AMS 210; CSE 214 or CSE 260
3 credits

**MAT 401: Seminar in Mathematics**
Discussions of a specific area of interest in mathematics. The work of each semester covers a different area of mathematics. May be repeated as topic changes. Prerequisites will be announced with the topic each time the course is offered.

**Prerequisites:** U3 or U4 standing; additional prerequisites announced with topic
3 credits

**MAT 402: Seminar in Mathematics**
Discussions of a specific area of interest in mathematics. The work of each semester covers a different area of mathematics. May be repeated as topic changes. Prerequisites will be announced with the topic each time the course is offered.

**Prerequisites:** U3 or U4 standing; additional prerequisites announced with topic
3 credits

**MAT 475: Undergraduate Teaching Practicum**
Each student assists in teaching a lower-division mathematics course or works in the Mathematics Learning Center. The student's work is regularly supervised by a faculty member. In addition, a weekly seminar is conducted. Responsibilities may include preparation of materials for student use and discussions, helping students with problems, and involvement in "alternative" teaching projects. Intended for upper-division students who have excelled in the calculus sequence. May not be used for major credit.

**Prerequisite:** Permission of the director of undergraduate studies
3 credits, S/U grading

**MAT 487: Independent Study in Special Topics**
A reading course for juniors and seniors. The topics may be chosen by the student with the approval of a supervising member of the faculty, who also takes responsibility for evaluation. A topic that is covered in a course regularly offered by the department is not appropriate for independent study. May be repeated.

**Prerequisite:** Permission of the director of undergraduate studies
0-6 credits

**MAT 495: Honors Thesis**
The student and a supervising faculty member together choose a topic in mathematics, and the student writes a substantial paper expounding the topic in a new way.

**Prerequisite:** Permission of the director of undergraduate studies
3 credits