MATHEMATICS (MATH)

MATH 504   Dynamical Systems   3 Credit Hours
This course is an introduction to nonlinear dynamics and chaos with applications taken from engineering and the sciences. Topics include: one dimensional flows and bifurcations, two dimensional linear systems, phase plane analysis, limit cycles, and bifurcations. The class will finish with an introduction to chaotic systems and strange attractors. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 404. Students cannot receive credit for both MATH 404 and MATH 504. (AY).
Prerequisite(s): MATH 228 and MATH 227
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 508   Topics for Elem and Mid Tchrs   1 to 4 Credit Hours
Topics such as problem solving, calculators, microcomputers, applications, algebraic and geometric concepts, probability and statistics are to be considered. Emphasis is on developing skills in these topics and their uses in the curriculum.
Prerequisite(s): MATH 385

MATH 508AF   Topics in Math education   2 Credit Hours
Topic: Graphing Calculators in Algebra and Data Analysis. This is one the courses for special education teachers and their general education partners teaching algebra at the middle or high school level. The sequence emphasizes a deep understanding of the mathematics and of the pedagogical issues in student learning the mathematics with a particular emphasis on the use of the graphing calculator on students understanding and fluency in algebraic thinking and data analysis concepts. This course is for 2 credits.

MATH 508AJ   Topics in Mathematics Educ   2 Credit Hours
Topic: Teaching Geometry with the Nspired Dynamic Geometry Software. This course is part of a sequence of courses for teachers of secondary school mathematics. This course focuses on the use of the dynamic geometry software Nspired to impact the teaching of geometry and student conceptual understanding of geometry. It will also discuss the pedagogical issues in the use the software. This is a two-credit course.

MATH 508N   Topics in Mathematics Educ   2 Credit Hours
Topic: Pedagogical Issues in Mathematics for Struggling Middle School Students. This course continues a sequence of courses for middle school teachers of mathematics offered by the Center of Mathematics Education in collaboration with Wayne RESA. Wayne RESA supports this sequence for districts and teachers who are not supported by either ITQ or MSP grants. It is a follow-up to the course Math 508L which focused on issues in student understanding of algebra. This course expands the focus to consider surrounding pre-algebra topics such as ratios and proportionality as well as geometry and measurement. The sequence emphasizes a deep understanding of the mathematics and the pedagogical issues in supporting struggling students attaining the expectations of Michigan's Grade Level Content Expectations. The course will be for 2 credits.

MATH 508Q   Topics for Elem and Mid Tchrs   2 Credit Hours
Topic: Elementary School Mathematics: Data Analysis and Probability. This course focuses on topics in data analysis and probability for teachers of elementary school mathematics. The data analysis topics include the construction, reading and interpretation of tables and graphs, understanding and calculating measures of central tendency and issues such as scaling, and maximum and minimum and range. The probability topics include the concept of probability and expressing probabilities of simple events as fractions. Important aspects of the work are representation and problem solving. This course will be 2 credit hours.

MATH 508T   Topics for Elem and Mid Tchrs   2 Credit Hours
Topic: Explorations and Investigations in Mathematics in the Upper Elementary Grades. This course is part of a sequence of courses for upper elementary grades teachers of mathematics. The sequence emphasizes a deep understanding of the mathematics and of the pedagogical issues in students' learning the mathematics embodied in the upper elementary grades standards-based curricula. This course will emphasize the content of topics in the Everyday Math series for the upper elementary grades. Its particular focus will be the explorations and investigations that engage students in learning the mathematics with particular attention paid to the use of calculators and games. This course is for 2 credit hours.

MATH 508X   Topics in Teacher Mathematics   3 Credit Hours
Topic: Focal Points in Algebra and Geometry: Middle School to High School. This course is part of a sequence of courses for teachers of middle school mathematics. This course focuses on the application of recently published Michigan middle school curriculum focal points to support student learning and deepen teacher knowledge of the mathematics undergirding the focal points. Important to this study is teacher understanding of the essential understanding students need to be successful in high school algebra and geometry. This is a two-credit course.

MATH 512   Introduction to Modern Algebra   4 Credit Hours
This course covers an introduction to group theory, ring theory and field theory. Topics in group theory include subgroups, group homomorphisms, factor groups, isomorphism theorems, simple groups, cyclic groups, dihedral groups and permutation groups. Topics in ring theory include ideals, integral domains, Euclidean domains, principal ideal domains, unique factorization domains, and modules. Topics in field theory include field extensions, Kronecker's theorem, and Galois Theory. Students cannot receive credit for both MATH 412 and MATH 512. (W).
Prerequisite(s): MATH 300 and MATH 228
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 513   Linear Algebra   3 Credit Hours
Vector Spaces, linear transformations and matrices, determinants, inner product spaces, bilinear and quadratic forms. Hamilton-Cayley theorem, eigenvalues and eigenvectors spectral theorem. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 413. Students cannot receive credit for both MATH 413 and MATH 513. (Y).
Prerequisite(s): MATH 300 and (MATH 217 or MATH 227)

MATH 514   Finite Difference Methods for Differential Equations   3 Credit Hours
This course studies the numerical solution of ordinary and partial differential equations using finite difference methods. Topics include convergence, stability, efficiency, numerical simulation and applications of these methods. (OC).
Prerequisite(s): MATH 228
Restriction(s):
Can enroll if Class is Graduate or Doctorate

MATH 516   Finite Element Methods for Differential Equations   3 Credit Hours
This course studies the numerical solution of ordinary and partial differential equations using finite element methods. Topics include convergence, stability, efficiency, numerical simulation and applications of these methods. (OC).
Prerequisite(s): MATH 227 and MATH 228
Restriction(s):
Can enroll if Class is Graduate

MATH 520   Stochastic Processes   3 Credit Hours
Review of distribution theory. Introduction to stochastic processes, Markov chains and Markov processes, counting, Poisson and Gaussian processes. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 420. Students cannot receive credit for both MATH 420 and MATH 520. (OC).
Prerequisite(s): MATH 325 or STAT 325 or IMSE 317 or ME 364
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 523   Applied Linear Algebra   3 Credit Hours
Review of elementary linear algebra concepts followed by the study of Gaussian elimination and solutions of systems of equations, matrix factorizations, inverses, vector spaces and subspaces, linear transformations, determinants, eigenspaces and eigen analysis, singular value decomposition. Applications may include discrete Fourier analysis, optimization, solutions of systems of differential equations and data science. Students cannot receive credit for both MATH 423 and MATH 523. (AY).
Prerequisite(s): MATH 228 and MATH 227
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 525   Mathematical Statistics   3 Credit Hours
Interval estimation and pivotal quantities; maximum likelihood estimation; hypothesis tests; linear models and analysis of variance; bivariate normal distribution, regression and correlation analysis; nonparametric methods. Additional reading assignments or projects will distinguish this course from its undergraduate version, MATH 425. Students cannot receive credit for both MATH 425 and MATH 525. (W).
Prerequisite(s): MATH 325 or STAT 325
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 5385   Nmbr Sys & Oper Tchrs   2 or 3 Credit Hours
This course is designed to deepen grades 3-5 elementary teachers' understanding of the whole number and rational number systems. Major topics include interpretations of whole number operations, the extension of whole number operations to rational numbers, the representations of rational numbers and the conceptual underpinnings of non-standard and standard algorithms. Other topics include analyzing number theoretic concepts such as prime numbers and divisibility. Pedagogical and curriculum issues will be addressed as they relate to teaching for understanding and developing computational fluency. The topics of the 2-credit hour course will include whole numbers and operations. The 3-credit course will extend topics covered to rational numbers. Open only to certified teachers. (OC)
Restriction(s):
Can enroll if Class is Graduate

MATH 5386   Geom & Meas 1 Tchrs   2 or 3 Credit Hours
This course will provide participants an opportunity to develop a deeper understanding of the mathematics they teach through a thorough development of the geometric and measurement concepts associated with two-dimensional figures. Topics will include characteristics and properties of geometric shapes with an emphasis on developing mathematical arguments about geometric relationships, transformations and use of symmetry to analyze mathematical situations, measurable attributes of objects and processes of measurement, and appropriate techniques, tools, and formulas to determine measurements. Coursework will focus on developing mathematical thinking and will highlight interactive learning styles. A three-credit course extends measurement to the real numbers by introducing the Pythagorean Theorem. Open only to certified teachers. (OC)

MATH 5387   Geom & Meas 2 Tchrs   2 or 3 Credit Hours
This course will provide participants an opportunity to develop a deeper understanding of the mathematics they teach through a thorough development of the geometric and measurement concepts associated with three-dimensional figures. Topics will include characteristics and properties of geometric shapes with an emphasis on developing mathematical arguments about geometric relationships and use of symmetry to analyze mathematical situations, measurable attributes of objects and processes of measurement, and appropriate techniques, tools, and formulas to determine measurements. In addition, topics to be covered include the Pythagorean Theorem. Coursework will also focus on developing mathematical thinking and will highlight interactive learning styles. Open to only certified teachers. (OC)
Restriction(s):
Can enroll if Class is Graduate

MATH 543   Algebra for Teachers   3 Credit Hours
Algebraic structure is emphasized, especially as it relates to arithmetic. Emphasis is on the development of algebraic reasoning and generalizations with appropriate pedagogy. Curriculum issues relevant to teaching algebra for conceptual understanding are included. Major topics include algebraic representations of linear, exponential, power and quadratic patterns, systems of equations, and applications. An investigative approach involving problem solving, reasoning and proof, connections, and communication will be emphasized. Classroom resources and materials are considered as well as calculators and computer technology as problem solving tools to aid in algebraic thinking. Open only to certified teachers or elementary education students. (F, W, S).
Prerequisite(s): MATH 386

MATH 544   Data Anlsys,Prob&Stat forTchrs   3 Credit Hours
Concepts of elementary probability using both experimental and theoretical models are considered with an emphasis on the use of probability models to describe physical phenomena and to make and interpret predictions. Topics in data analysis and statistics include drawing inferences from visual displays of data, applying techniques of inferential statistics, sampling and simulations to generate solutions to problems, and making appropriate inferences using best fit techniques. Evaluation of data and arguments to establish validity, interpreting, calculating and solving problems related to correlation, distributions, percentiles and standard scores are also included. An investigative approach involving problem solving, reasoning and proof, connections and communication will be emphasized. Calculator and computer technology will support the investigation of these topics. Open only to certified teachers or elementary education students.
Prerequisite(s): MATH 387
Restriction(s):
Can enroll if Class is Graduate

MATH 5440   Pedagogy Content Alg Tchrs I   2 or 3 Credit Hours
This is the first in a sequence of courses for secondary school teachers of mathematics. The sequence emphasizes a deep understanding of the mathematics and the pedagogical issues in students learning the mathematics embodied in the algebra components of secondary school mathematics as defined in the Michigan Merit Exam in mathematics for graduation from high school. The first two courses in this sequence emphasize the algebra and the algebraic reasoning basic to student success in Algebra I, and the beginning of Algebra II. The three credit hour course furthers teachers? understanding of the use of mathematical models to represent quantitative relationships. Pedagogical and curriculum issues will be addressed as they relate to teaching for students? understanding of patterns and algebraic content.
Restriction(s):
Can enroll if Class is Graduate

MATH 5441   Pedagogy Content Alg Tchrs II   2 or 3 Credit Hours
This is the second in a sequence of courses for secondary school teachers of mathematics. The sequence emphasizes a deep understanding of the mathematics and the pedagogical issues in students learning the mathematics embodied in the algebra components of secondary school mathematics as defined in the Michigan Merit Exam in mathematics for graduation from high school. The first two courses in this sequence emphasize the algebra and the algebraic reasoning basic to student success in Algebra I and the beginning of Algebra II. The three credit hour course furthers teachers? understanding of the use of mathematical models to represent quantitative relationships. Pedagogical and curriculum issues will be addressed as they relate to teaching for students? understanding of patterns and algebraic content.
Restriction(s):
Can enroll if Class is Graduate

MATH 5442   Geom & Meas 3 Tchrs   2 or 3 Credit Hours
This course will provide participants an opportunity to develop a deeper understanding of the mathematics they teach through a thorough development of the geometric and measurement concepts associated with two- and three-dimensional figures. Topics will include characteristics and properties of geometric shapes with an emphasis on developing mathematical arguments about geometric relationships, transformations and use of symmetry to analyze mathematical situations, measurable attributes of objects and processes of measurement, and appropriate techniques, tools, and formulas to determine measurements. In addition, topics to be covered include Pythagorean Theorem and right-angle trigonometric concepts. Coursework will also focus on developing mathematical thinking and will highlight interactive learning styles. Open only to certified teachers. (OC)
Restriction(s):
Can enroll if Class is Graduate

MATH 5443   Patterns Algebra 2 Tchrs   2 or 3 Credit Hours
This course is designed to deepen in-service teachers' understanding of patterns and algebraic concepts. Major topics include the representation, analysis, and generalization of a variety of linear and non-linear patterns (including exponential and quadratic) with tables, graphs, words, and symbolic rules; the comparing and contrasting of linear and non-linear patterns; the representation and analysis of mathematical situations and structures using algebraic symbols; the use of mathematical models to represent and understand quantitative relationships; and the analysis of change in various contexts. Pedagogical and curriculum issues will be addressed as they relate to teaching for students' understanding of patterns and algebraic concepts. Open only to certified teachers. (OC)
Restriction(s):
Can enroll if Class is Graduate

MATH 5445   Nmbr Sys Oper&Prop Reas Tch   2 or 3 Credit Hours
This course is designed to deepen middle school mathematics teachers' understanding of the whole number system and its operations and its extensions to the rational number system and their operations. The primary focus is on proportional reasoning as a major ingredient for success in mathematics. Pedagogical and curriculum issues will be addressed as they relate to teaching for understanding. Materials include exemplary curriculum materials and records of student thinking. Only open to certified teachers. (OC)
Restriction(s):
Can enroll if Class is Graduate

MATH 545   Number & Prop'l Rsng for Tchrs   3 Credit Hours
This course deepens previous work on rational number ideas and applications and explores the concepts of ratio and proportion. Content includes a variety of situations involving proportions, for example, real-world problems involving ratios, rates, and percents; geometry involving similarity; algebra involving linearity; probability involving assigning a probability to an event; and trigonometry involving slope. Distinguishing proportional situations from those that are not and reasoning proportionally in appropriate situations are emphasized. The course includes problem solving, reasoning and proof, connections, communication, and multiple representations. Open only to certified teachers or elementary education students. (YR).
Prerequisite(s): (MATH 442 or MATH 542) and (MATH 443 or MATH 543)
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

MATH 546   Discrete Math/Modeling for Tch   3 Credit Hours
This course interweaves the ideas of discrete mathematics with the approaches and strategies of mathematical modeling. It gives pre- and in-service teachers opportunities to deepen their understanding and use of mathematical models based on the concepts of discrete mathematics. Topics include recurrence, induction, permutations, combinations, binomial distributions, circuits, critical paths, minimal spanning trees, adjacency matrices, algorithm design and optimization. Systems thinking and multiple representations are emphasized. Open only to certified teachers or elementary education students. (YR).
Prerequisite(s): (MATH 442 or MATH 542) and (MATH 443 or MATH 543)
Restriction(s):
Can enroll if Class is Professional Development or Graduate

MATH 549   Concepts of Calc for Teachers   3 Credit Hours
Concepts of Calculus for Teachers focuses on calculus concepts appropriate for middle school mathematics teachers and teacher-candidates. The course provides a deep understanding of the major concepts of calculus: rates of change, accumulation (net change), area, and limits. Students will experience concrete approaches to the various topics using problem solving, manipulatives and technology as appropriate, with the intent being to help the learners discover how the ideas of calculus are useful in a variety of settings. Visual, numeric, and commonsense approaches will be used. Open only to certified teachers or elementary education students. (YR).
Prerequisite(s): (MATH 442 or MATH 542) and (MATH 443 or MATH 543)
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

MATH 551   Advanced Calculus   4 Credit Hours
Topics for this course include properties of the real number system, point set theory for the real line and the Bolzano-Weierstrass theorem, sequences, functions of one variable, limits and continuity, differentiability, continuous nowhere-differentiable functions, Riemann integrability, Lebesgue's criterion for Riemann integrability, and series of functions. Students cannot receive credit for both MATH 451 and MATH 551. (F, YR).
Prerequisite(s): MATH 300 and MATH 228 and MATH 227
Restriction(s):
Can enroll if Class is Graduate

MATH 552   Advanced Calculus II   3 Credit Hours
Includes the rigorous study of two and more variables, partial differentiation and multiple iteration. Special topics include: Taylor Series, Implicit Function Theorem, Weierstrass Approximation Theorem, Arzela-Ascoli Theorem. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 452. Students cannot receive credit for both MATH 452 and MATH 552. (AY)
Prerequisite(s): MATH 451 or MATH 551
Restriction(s):
Can enroll if Class is Graduate

MATH 554   Fourier Series and Boundary Value Problems   3 Credit Hours
Fourier series and integrals. Their use in solving boundary value problems of mathematical physics by the method of separation of variables. Sturm-Liouville theory and generalized Fourier series, including those involving Bessel functions and Legendre polynomials, with applications. Students cannot receive credit for both MATH 454 and MATH 554. (YR).
Prerequisite(s): MATH 215 and MATH 228
Restriction(s):
Can enroll if Class is Graduate

MATH 555   Func of a Complex Var with App   3 Credit Hours
Complex number system. Functions of a complex variable, their derivatives and integrals. Taylor and Laurent series expansions. Residue theory and applications, elementary functions, conformal mapping, and applications to physical problems. Students cannot receive credit for both MATH 455 and MATH 555. (F,S).
Prerequisite(s): MATH 228 and MATH 215

MATH 558   Introduction to Wavelets   3 Credit Hours
This course will introduce the students to theory and application of wavelets using linear algebra. Topics will include the discrete Fourier transform, the fast Fourier transform, linear transformations, orthogonal decomposition, discrete wavelet analysis, the filter bank, Haar Wavelet family, and applications. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 458. Students cannot receive credit for both MATH 458 and MATH 558. (OC)
Prerequisite(s): MATH 227
Restriction(s):
Can enroll if Class is Graduate

MATH 562   Mathematical Modeling   3 Credit Hours
The processes of constructing, implementing, and evaluating mathematical models of real world phenomena are investigated. Models involving continuous and discrete mathematical constructs are considered. Deterministic and stochastic models are compared. Examples are taken from genetics, epidemiology, queuing theory, and other fields. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 462. Students cannot receive credit for both MATH 462 and MATH 562. (F).
Prerequisite(s): MATH 215 and MATH 228
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 572   Introduction to Numerical Analysis   3 Credit Hours
This course is an introduction to numerical analysis and scientific computing. Topics include: floating point representation, round off error, root finding techniques, interpolation, numerical integration, Gaussian elimination and techniques for solving linear systems, minimizing functions, and methods for solving ordinary differential equations numerically. Students cannot receive credit for both MATH 472 and MATH 572. (F).
Prerequisite(s): MATH 227 or MATH 228
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 573   Matrix Computation   3 Credit Hours
A study of the most effective methods for finding the numerical solution of problems which can be expressed in terms of matrices, including simultaneous linear equations, orthogonal projections and least squares, eigenvalues and eigenvectors, positive definite matrices, and difference and differential equations. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 473. Students cannot receive credit for both MATH 473 and MATH 573. (AY).
Prerequisite(s): MATH 217 or MATH 227
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 586   Sec School Math for Teachers   3 Credit Hours
Basic concepts, relationships, generalizations, and applications from the secondary school mathematics curriculum are discussed both from an advanced viewpoint and from the standpoint of the learner. Included are the roles of technology, problem solving, and current thinking on the teaching of secondary mathematics topics. Open only to certified teachers or secondary education students. (OC).
Prerequisite(s): MATH 217 or MATH 227
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 590   Topics in Mathematics   3 Credit Hours
A course designed to offer selected topics in different areas of mathematics. The specific topic or topics will be announced together with the prerequisites when offered. Course may be repeated for credit when specific topic differs. (OC).
Prerequisite(s): MATH 227 or MATH 228
Restriction(s):
Can enroll if Class is Graduate

MATH 591   Topics in Math for Teachers   1 to 3 Credit Hours
A course designed to offer selected topics in different areas of mathematics for teachers of mathematics. The specific topic or topics will be announced together with the prerequisites when offered. Course may be repeated for credit when specific topics differ. (OC).

MATH 591K   Topics in Math and Statistics   1 Credit Hour
TOPIC TITLE: Summer Geometry Workshop for Teachers Part 2

MATH 592   Introduction to Topology   3 Credit Hours
Metric spaces, topological spaces, continuous maps, connectedness, compactness, separation axioms. Additional reading assignments or projects will distinguish this course from its undergraduate version MATH 492. Students cannot receive credit for both MATH 492 and MATH 592. Prior experience in a proof based course is recommended. (OC).
Prerequisite(s): MATH 300
Restriction(s):
Can enroll if Level is Rackham or Graduate

MATH 597   Indep Studies in Mathematics   1 to 3 Credit Hours
Independent Study in mathematics for topics at the graduate level. Topics and objectives chosen bt agreement between students and instructor.

MATH 598   Indep Study in Math Education   1 to 6 Credit Hours
Independent study project in Mathematics Education under the supervision of a faculty member.
Restriction(s):
Can enroll if Class is Post-baccalaureate Cert only or Post-baccalaureate NCFD or Graduate

MATH 599   Independent Research Project   1 to 3 Credit Hours
Independent research project in applied mathematics or statistics with a faculty or industrial collaborator under the supervision of a faculty member. (YR).
Restriction(s):
Can enroll if Class is Graduate

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally