

# 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 of 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 of 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. Applications to queuing theory. 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

**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

**Restriction(s):**

Can enroll if Level is Rackham or Graduate

**MATH 5385 Nbr 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 Nnbr 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 Rsgng 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

**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 by 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