

# MATHEMATICS (UNIV) (MATH)

Mathematics courses numbered below 136 are not applicable toward a major or minor in mathematics. A student who has earned credit for the listed course with a grade of "C" or better may not subsequently receive credit for the courses following in parentheses: MATH 116/MATH 123 (MATH 115); MATH 117 (MATH 115 and 116/123); MATH 118 (MATH 115, 116 and 117), MATH 119 (MATH 115, 116/123, and 118), MATH 136 (MATH 115, 116/123, 117, 118, and 119); MATH 137 (MATH 115, 116/123, 117, 118, 119, and 136); MATH 310 (MATH 109); MATH 382 (MATH 109 and 183); STAT 301 (MATH 109 and 183). Students may only take the courses MA TH 116 and MA TH 123 for a total of three graded attempts.

## MATH 105 Corequisite Support for Algebra 1 Hour

Corequisite support for students in Math 115C, Math 116C, or Math 123. Topics include functions, graphs and fundamental concepts of algebra.

**Prerequisite(s):** MA 115C (may be taken concurrently) or MA 116C (may be taken concurrently) or MATH 123 (may be taken concurrently)

*Recent Term(s) Offered:* spring 2020; summer 2020; fall 2020; winter 2021; spring 2021; summer 2021; fall 2021; winter 2022; spring 2022; summer 2022; fall 2022

## MATH 109 General Mathematics 3 Hours

Terminal course for non-science majors suggested for the student who has satisfactorily completed minimum high school mathematics requirements and needs no further work in algebra. Topics include sets, introduction to probability and statistics, geometry, and consumer mathematics. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (ACT Math with a score of 19 or SAT Mathematics Score with a score of 510 or HS GPA Transcript with a score of 3.0)

**Equivalent(s):** MA 109C

*Recent Term(s) Offered:* spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; summer 2022; fall 2022

## MATH 112 Problem Solving and Mathematical Skills for Teachers 3 Hours

Development of mathematical skills and problem-solving techniques necessary for pre-service teachers. Topics include: number and algebra, geometry, probability and statistics. **Colonnade/Statewide General Education Code F-QR | QR**

*Recent Term(s) Offered:* spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022

## MATH 115 Applied College Algebra 3 Hours

Intended primarily for students who are not majoring in a scientific or technical field; not intended for students whose curriculum requires trigonometry or calculus. Emphasis is on real-world problems that involve reading, writing, calculating, synthesizing, and clearly reporting results. Topics include linear, quadratic, exponential and logarithmic functions, and systems of equations. (Graphing calculator required). **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (ACT Math with a score of 22 or SAT Mathematics Score with a score of 540 or MPE - Algebra with a score of 14 or KYOTE College Algebra with a score of 14 or Compass - Algebra with a score of 50 or HS GPA Transcript with a score of 3.5)

**Equivalent(s):** MA 115C

*Recent Term(s) Offered:* spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022

## MATH 116 College Algebra 3 Hours

Graphing and problem solving are integrated throughout the study of polynomial, absolute value, rational, radical, exponential, and logarithmic functions. (Graphing calculator required.) **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (MPE - Algebra with a score of 14 or SAT Mathematics Score with a score of 540 or ACT Math with a score of 22 or KYOTE College Algebra with a score of 14 or HS GPA Transcript with a score of 3.5)

**Equivalent(s):** MA 116C

*Recent Term(s) Offered:* spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022

## MATH 117 Trigonometry 3 Hours

Unit circle; trigonometric functions and graphs; trigonometric identities and equations; right triangle trigonometry; laws of sines and cosines; DeMoivre's Theorem; vectors and applications of trigonometry. (Graphing calculator required.) Note: Four years of high school mathematics including Algebra I and II and geometry may be required. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (ACT Math with a score of 27 or (ACT Math with a score of 22 and MPE - Algebra with a score of 18) or (MATH 116 with a minimum grade of C or MATH 116E with a minimum grade of C or MA 116C with a minimum grade of C or MATH 123 with a minimum grade of C) or SAT Mathematics Score with a score of 610 or (SAT Mathematics Score with a score of 540 and MPE - Algebra with a score of 18))

**Equivalent(s):** MA 117C

*Recent Term(s) Offered:* spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022

## MATH 118 College Algebra and Trigonometry 5 Hours

Real number system, algebraic manipulations, and solutions of equations and inequalities, absolute value, exponential and logarithmic functions, trigonometry, systems of equations, complex numbers. (Graphing calculator required.) Note: Four years of high school mathematics including Algebra I and II and geometry may be required. **Colonnade/Statewide General Education Code QR**

**Prerequisite(s):** (ACT Math with a score of 22 and MPE - Algebra with a score of 18)

*Recent Term(s) Offered:* None

## MATH 119 Fundamentals of Calculus 4 Hours

An introduction to calculus designed for non-science and non-technical majors. Applications are directed toward the management sciences and related areas. Not accepted for credit toward a mathematics major or minor. (Graphing calculator required.) Note: Four years of high school mathematics, including Algebra I and II and geometry, and a satisfactory score on Math Placement exam are required if MATH 116 or MATH 118 has not been met. **Colonnade/Statewide General Education Code QR**

**Prerequisite(s):** (MATH 116 with a minimum grade of C or MA 116C with a minimum grade of C or MATH 118 with a minimum grade of C)

*Recent Term(s) Offered:* None

## MATH 121 Computational Problem Solving 4 Hours

Students will tackle problems ranging from elementary to advanced, using mathematical methods, algorithmic techniques, and computational methods. This course is taught jointly by mathematics and computer science faculty. Note: Enrollment in Gatton Academy of Mathematics and Science in Kentucky is required.

**Corequisite(s):** MATH 117

**Equivalent(s):** CS 121

*Recent Term(s) Offered:* None

**MATH 123 Mathematical Applications for Business 3 Hours**

Business applications of linear, quadratic, exponential and logarithmic functions, plus a brief introduction to probability, the mathematics of finance, and derivatives as they apply to problem-solving strategies in business-related fields. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (ACT Math with a score of 22 or SAT Mathematics Score with a score of 540 or MPE - Algebra with a score of 14 or KYOTE College Algebra with a score of 14 or HS GPA Transcript with a score of 3.5) or (HS GPA Transcript with a score of 2.0 and MATH 105 (may be taken concurrently))

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; fall 2021; winter 2022; spring 2022; fall 2022*

**MATH 127 Applied Geometry 3 Hours**

Euclidean geometry with historical applications, including tilings, fractals, circles and spiral designs, celestial themes, special topics in linear algebra, and the origins of perspective.

**Prerequisite(s):** (MATH 116 with a minimum grade of C or MATH 116E with a minimum grade of C or MA 116C with a minimum grade of C or ACT Math with a score of 22 or MPE - Algebra with a score of 18 or ACT Math with a score of 27)

*Recent Term(s) Offered: None*

**MATH 136 Calculus I 4 Hours**

A course in one-variable calculus including topics from analytic geometry. Limits, derivatives, integration, and applications of polynomial, rational, trigonometric and transcendental functions. Includes lecture and recitation. Note: Four years of high school mathematics including Algebra II, geometry may be required. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** ((ACT Math with a score of 27 or SAT Mathematics Score with a score of 640) or (ACT Math with a score of 22 and MPE - Algebra with a score of 20) or (SAT Mathematics Score with a score of 540 and MPE - Algebra with a score of 20) and MPTE - Trigonometry with a score of 10 or (MATH 117 with a minimum grade of C or MA 117C with a minimum grade of C or MATH 118 with a minimum grade of C))

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 137 Calculus II 4 Hours**

A second course in one-variable calculus including topics from analytic geometry. Methods of integration, sequences and series, polar and parametric functions. Includes lecture and recitation.

**Prerequisite(s):** MATH 136 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 142 Calculus with Applications for Life Sciences 5 Hours**

Exponential and logarithmic functions, derivatives, integration, first order differential equations, and systems of linear equations, with major emphasis on applications in life sciences. Note: Four years of high school mathematics, including Algebra I and II, geometry, and a course that includes trigonometry is required if MATH 117 and MATH 118 has not been met. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (ACT Math with a score of 22 and MPE - Algebra with a score of 20 and MPTE - Trigonometry with a score of 10) or (ACT Math with a score of 27 and MPTE - Trigonometry with a score of 10) or (MATH 117 (may be taken concurrently) with a minimum grade of C or MA 117C (may be taken concurrently) with a minimum grade of C or MATH 118 with a minimum grade of C)

*Recent Term(s) Offered: None*

**MATH 183 Introductory Statistics 3 Hours**

Introduction to elementary probability theory. The analysis of data by means of frequency distributions and the statistics which describe them. The binomial and normal probability distributions. Statistical inference. Emphasis is on applied real world problems. Not accepted for credit toward a mathematics major or minor. **Colonnade/Statewide General Education Code F-QR | QR**

**Prerequisite(s):** (MPE - Algebra with a score of 14 or SAT Mathematics Score with a score of 540 or ACT Math with a score of 22 or KYOTE College Algebra with a score of 14 or MATH 109 with a minimum grade of C or MA 109C with a minimum grade of C or MATH 112 with a minimum grade of C or MATH 115 with a minimum grade of C or MA 115C with a minimum grade of C or MATH 116 with a minimum grade of C or MA 116C with a minimum grade of C or MATH 117 with a minimum grade of C or MATH 123 with a minimum grade of C or MATH 136 with a minimum grade of C or MATH 142 with a minimum grade of C or HS GPA Transcript with a score of 3.5)

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 205 Number Systems and Number Theory for Teachers 3 Hours**

Development of conceptual understanding of elementary place value, operations on whole numbers and integers, number theory, basic algebra and functions.

**Prerequisite(s):** (MATH 112 with a minimum grade of C or MATH 116 with a minimum grade of C or MA 116C with a minimum grade of C or MATH 117 with a minimum grade of C or MATH 136 with a minimum grade of C or MATH 183 with a minimum grade of C)

**Restriction(s):** Enrollment is limited to students in Special Ed: LBD and Elm Edu (5003) , Elementary Education (527) , Exceptional Ed - LBD and MSD (553) , Middle Grades Education (579) , Mathematics (728) , Mathematics-Prep (728P) , Middle Grades Mathematics (730) or Middle Grades Mathematics-Prep (730P)

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 206 Fundamentals of Geometry for Teachers 3 Hours**

Conceptual development of fundamental concepts of geometry and measurement. Note: Completion of general education math course is required.

**Prerequisite(s):** MATH 205 with a minimum grade of C

**Restriction(s):** Enrollment is limited to students in Special Ed: LBD and Elm Edu (5003) , Elementary Education (527) , Exceptional Ed - LBD and MSD (553) , Middle Grades Education (579) , Mathematics (728) , Mathematics-Prep (728P) , Middle Grades Mathematics (730) or Middle Grades Mathematics-Prep (730P)

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 237 Multivariable Calculus 4 Hours**

Topics in real-valued functions of several variables including directional derivatives, implicit functions, gradient, Taylor's Theorem, maxima, minima, and Lagrange multipliers. Differential calculus of vector-valued functions including chain rule and Inverse Function Theorem. Multiple integrals, line integrals, surface integrals, Stokes' and Green's Theorems.

**Prerequisite(s):** MATH 137 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022*

**MATH 240 Geometry in Art and Architecture 3 Hours**

Euclidean geometry with historical applications in art and architecture, such as tiling, circular and spiral designs, designs of the great cathedrals in Europe, Buddhist stupas in Asia, Islamic art, the development of visual perspective, and musical ratios. **Colonnade/Statewide General Education Code K-SY**

**Prerequisite(s):** 21 hours of Foundations and Explorations Courses, or junior status and (MATH 112 with a minimum grade of B or MATH 116 with a minimum grade of B or MATH 115 with a minimum grade of B or MATH 117 with a minimum grade of B or MATH 109 with a minimum grade of B or MATH 136 with a minimum grade of B or MATH 142 with a minimum grade of B or MATH 183 with a minimum grade of B)

**Equivalent(s):** HUM 240

*Recent Term(s) Offered: None*

**MATH 270 The Mathematics of Social Justice 3 Hours**

Use of mathematical and statistical tools to examine social justice topics on local, regional, national, and global scales. **Colonnade/Statewide General Education Code K-LG**

**Prerequisite(s):** 21 hours of Foundations and Explorations Courses, or junior status

*Recent Term(s) Offered: None*

**MATH 275 Introductory Topics in Mathematics 1-3 Hours** (repeatable max of 3 hrs)

Varied topics selected to give students an early introduction to interesting mathematical problems or applications not found in the foundation sequence. Note: Permission of instructor required.

**Prerequisite(s):** MATH 136

*Recent Term(s) Offered: spring 2020; fall 2020; winter 2021; spring 2021; fall 2021; spring 2022*

**MATH 295 Introduction to Research Methodology 1 Hour**

To familiarize Ogden Research Scholars and other interested students with the fundamentals of choosing a research topic, performing a bibliographical search on a subject, classification of instruments, data taking, data reduction, professional ethics and related topics. The common points of research methodology in the different scientific areas will be emphasized, with examples drawn from various disciplines. Computers will be utilized. (Course does not count toward any major or minor.) Note: Ogden Research Scholar, or 3.2 grade point average at the end of freshman year or Ogden College faculty member recommendation is required.

**Equivalent(s):** ENGR 295, CHEM 295, GEOL 295, BIOL 295, CS 295, PHYS 295

*Recent Term(s) Offered: None*

**MATH 302 Introduction to Advanced Mathematics for Middle Grades Teachers 3 Hours**

Development of skills in reasoning, justification, abstraction, generalization, and making connections through the study of selected topics from logic, sets, relations and functions, combinatorics, number theory, graph theory, and matrix algebra, as appropriate for middle grades mathematics teachers.

**Prerequisite(s):** MATH 136

*Recent Term(s) Offered: spring 2020; fall 2020; fall 2021; fall 2022*

**MATH 304 Functions, Applications and Explorations 3 Hours**

In-depth study of mathematical topics used in teaching pre-calculus and transition-to-calculus courses at the middle and secondary school levels. Modeling with linear, exponential, and trigonometric functions; curve fitting; discrete and continuous models.

**Prerequisite(s):** MATH 137 with a minimum grade of C or (MATH 225 with a minimum grade of C or MATH 302 with a minimum grade of C)

*Recent Term(s) Offered: spring 2020; spring 2021; spring 2022*

**MATH 305 Introduction to Mathematical Modeling 3 Hours**

Theory and computer implementation of mathematical models. Deterministic, stochastic, discrete, continuous, and matrix models. Introduction to advanced topics such as linear algebra, differential and difference equations, probability, stochastic processes, and dynamical systems.

**Prerequisite(s):** MATH 137 with a minimum grade of C

*Recent Term(s) Offered: fall 2020; fall 2022*

**MATH 306 Applied and Computational Linear Algebra 3 Hours**

Basic concepts and computational techniques of matrix and linear algebra. Practical methods using computer software for small-to-large data sets. Applications in economics, finance, informatics, statistics, and social, engineering, physical and biological sciences. Computer assignments are required. Not accepted for credit toward a mathematics major or minor.

**Prerequisite(s):** (MATH 116 with a minimum grade of C or MA 116C with a minimum grade of C) and (MATH 183 with a minimum grade of C or MATH 136 with a minimum grade of C or MATH 142 with a minimum grade of C)

*Recent Term(s) Offered: None*

**MATH 307 Introduction to Linear Algebra 3 Hours**

Systems of linear equations, matrix algebra, vector spaces, inner product spaces, linear transformations, eigenvectors, quadratic forms.

**Prerequisite(s):** (MATH 137 with a minimum grade of C or MATH 136 with a minimum grade of A or MATH 142 with a minimum grade of A) or (MATH 136 with a minimum grade of C and CS 290 with a minimum grade of C)

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022*

**MATH 308 Rational Numbers and Data Analysis for Teachers 3 Hours**

Conceptual development of rational number system, including operations with and relationships among fractions, decimals, and percents; elementary probability and statistics.

**Prerequisite(s):** MATH 205 with a minimum grade of C

**Restriction(s):** Enrollment is limited to students in Special Ed: LBD and Elm Edu (5003), Elementary Education (527), Mathematics (728), Mathematics-Prep (728P), Middle Grades Mathematics (730) or Middle Grades Mathematics-Prep (730P)

*Recent Term(s) Offered: spring 2020; summer 2020; fall 2020; spring 2021; summer 2021; fall 2021; spring 2022; summer 2022; fall 2022*

**MATH 310 Introduction to Discrete Mathematics 3 Hours**

Introduction to discrete topics. Development of skills in abstraction and generalization. Set theory, functions and relations, mathematical induction, elementary propositional logic, quantification, truth tables, validity; counting techniques, pigeonhole principle, permutations and combinations; recurrence relations and generating functions; elementary graph theory, isomorphisms, trees.

**Prerequisite(s):** MATH 137 with a minimum grade of C

*Recent Term(s) Offered:* spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022

**MATH 315 Theory of Numbers 3 Hours**

A study of the arithmetic of the integers, divisibility, prime numbers, factorization, diophantine equations, congruences, quadratic residues.

**Prerequisite(s):** MATH 307 with a minimum grade of C

*Recent Term(s) Offered:* None

**MATH 317 Introduction to Algebraic Systems 3 Hours**

Introduction to groups, rings, polynomial rings, integral domains, and fields.

**Prerequisite(s):** MATH 307 with a minimum grade of C and MATH 310 with a minimum grade of C

*Recent Term(s) Offered:* spring 2020; fall 2020; fall 2021; fall 2022

**MATH 323 Geometry I 3 Hours**

An axiomatic development of Euclidean and absolute plane geometry.

**Prerequisite(s):** MATH 310 with a minimum grade of C

*Recent Term(s) Offered:* fall 2020; fall 2021; fall 2022

**MATH 331 Differential Equations 3 Hours**

Methods of solution of differential equations, existence and nature of solutions, Laplace transform method, infinite series and numerical solutions, and applications.

**Prerequisite(s):** MATH 137 with a minimum grade of C

*Recent Term(s) Offered:* spring 2020; summer 2020; fall 2020; spring 2021; fall 2021; spring 2022; summer 2022; fall 2022

**MATH 337 Elements of Real Analysis 3 Hours**

Basic concepts and techniques of real analysis, including proofs by induction and contradiction, the number system, functions of real variables, sets, series and sequences, cardinality, continuity, convergence, and elementary topology.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 307 with a minimum grade of C and MATH 310 with a minimum grade of C

*Recent Term(s) Offered:* spring 2020; spring 2021; spring 2022

**MATH 350 Advanced Engineering Mathematics 3 Hours**

Special topics in Laplace transforms, linear algebra and complex analysis. Designed for engineering students.

**Prerequisite(s):** MATH 331

*Recent Term(s) Offered:* None

**MATH 370 Applied Techniques in Mathematics 3 Hours**

Matrices, systems of ordinary differential equations, complex variables, and at least one of the topics from Fourier analysis, numerical analysis or optimization (linear programming, Lagrange multipliers).

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 331 with a minimum grade of C

*Recent Term(s) Offered:* spring 2020; spring 2021

**MATH 371 Advanced Computational Problem Solving 3 Hours**

Problem-solving tools and techniques, with an emphasis on mathematical reasoning, algorithmic techniques, and computational methods. Techniques and tools are applied to (research) areas of interest to enrolled students, in the context of a project involving program design and implementation. The course is taught jointly by mathematics and computer science faculty. Note: Enrollment in the Gatton Academy of Mathematics and Science or Honors Program eligibility at WKU required.

**Prerequisite(s):** CS 180 with a minimum grade of C and MATH 136 (may be taken concurrently)

**Equivalent(s):** CS 371

*Recent Term(s) Offered:* spring 2020; spring 2021; spring 2022

**MATH 382 Probability and Statistics I 3 Hours**

Axioms and laws of probability; discrete and continuous probability distributions; multivariate distributions; random variables; expectation; moment generating functions; Central Limit Theorem.

**Prerequisite(s):** MATH 310 with a minimum grade of C and MATH 237 (may be taken concurrently)

*Recent Term(s) Offered:* fall 2020; fall 2021; fall 2022

**MATH 398 Seminar 1 Hour (repeatable max of 3 hrs)**

Students will work on a topic of interest under the direction of a mathematics faculty member, who will set the requirements for the course. Mathematics majors could have the opportunity to continue this work in MATH 498.

**Prerequisite(s):** MATH 237 with a minimum grade of C

*Recent Term(s) Offered:* spring 2021

**MATH 403 Geometry for Elementary and Middle School Teachers 3 Hours**

Both formal and informal methods are used to explain the basic concepts of Euclidean geometry. Emphasis is given to the investigative approach, organizational skills, and problem solving. Note: (For students in the early grades (K-4) teacher certification program or students pursuing middle grades (5-8) certification with a mathematics emphasis.)

**Prerequisite(s):** MATH 206 with a minimum grade of C and (MATH 225 with a minimum grade of C or MATH 302 with a minimum grade of C)

*Recent Term(s) Offered:* spring 2020; summer 2020; spring 2021; spring 2022

**MATH 405 Numerical Analysis I 3 Hours**

Computer arithmetic, roots of equations, polynomial approximation and interpolation, numerical differentiation and integration. Computer solutions of problems will be required.

**Prerequisite(s):** MATH 137 with a minimum grade of C and (MATH 237 with a minimum grade of C or MATH 307 with a minimum grade of C or MATH 310 with a minimum grade of C) and (CS 146 with a minimum grade of C or CS 180 with a minimum grade of C)

**Equivalent(s):** CS 405

*Recent Term(s) Offered:* fall 2020; fall 2021; fall 2022

**MATH 406 Numerical Analysis II 3 Hours**

The solution of linear systems by direct and iterative methods, matrix inversion, the calculation of eigenvalues and eigenvectors of matrices. Initial and boundary value problems in ordinary differential equations. Computer solution of problems will be required.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 307 with a minimum grade of C and MATH 331 with a minimum grade of C and (MATH 405 with a minimum grade of C or CS 405 with a minimum grade of C)

*Recent Term(s) Offered:* spring 2020

**MATH 409 History of Mathematics 3 Hours**

History of mathematics from ancient times through the development of calculus, with emphasis on famous problems. Provides knowledge and appreciation useful in the classroom. This course cannot be accepted as part of the 35-hour requirement for the non-certifiable mathematics major. Term papers will be required. Note: Six hours of approved mathematics courses at the 300 and/or 400 level or permission of instructor required.

*Recent Term(s) Offered: None*

**MATH 411 Problem Solving for Elementary and Middle School Teachers 3 Hours**

Integrates concepts developed in algebra, geometry, logic, statistics, probability, and elementary number theory. Students are encouraged to use problem-solving strategies, models, and technologies, and to create problems of their own.

**Prerequisite(s):** MATH 206 with a minimum grade of C and (MATH 225 with a minimum grade of C or MATH 302 with a minimum grade of C) and MATH 308 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; fall 2020; fall 2021; fall 2022*

**MATH 413 Algebra and Technology for Middle Grades Teachers 3 Hours**

The use of graphing calculators and computer software to explore algebraic ideas including patterns, functions, equations, inequalities, linear programming, curve fitting, and practical applications of algebra and technology.

**Prerequisite(s):** (MATH 302 with a minimum grade of C or MATH 137 with a minimum grade of C)

*Recent Term(s) Offered: fall 2020; fall 2021; fall 2022*

**MATH 415 Algebra and Number Theory 3 Hours**

An integrated survey of modern algebra and number theory. Topics include number systems, divisibility, congruences, groups and their application to number theory.

**Prerequisite(s):** (MATH 315 with a minimum grade of C or MATH 317 with a minimum grade of C)

*Recent Term(s) Offered: None*

**MATH 417 Algebraic Systems 3 Hours**

The theory of finite groups and related algebraic systems. Lagrange's Theorem, Sylow Theorems, and the structure of finite groups are studied. Applications of group theory to the study of algebraic problems and symmetry.

**Prerequisite(s):** MATH 317 with a minimum grade of C

*Recent Term(s) Offered: spring 2022*

**MATH 421 Problem Solving for Secondary Teachers 3 Hours**

Utilizes various techniques and technology to solve mathematical problems. Integrates concepts from algebra, geometry, trigonometry, probability, statistics, number theory, discrete mathematics, linear algebra, and calculus. Note: Permission of instructor may be required.

**Prerequisite(s):** MATH 137 with a minimum grade of C and (MATH 307 with a minimum grade of C or MATH 310 with a minimum grade of C)

*Recent Term(s) Offered: spring 2020; spring 2021; spring 2022*

**MATH 423 Geometry II 3 Hours**

An axiomatic development of hyperbolic geometry based on the hyperbolic parallel postulate and the absolute geometry developed in MATH 323, including an emphasis on contrasts with Euclidean geometry. Note: Permission of instructor may be required.

**Prerequisite(s):** MATH 323 with a minimum grade of C and MATH 137 with a minimum grade of C

*Recent Term(s) Offered: None*

**MATH 431 Intermediate Analysis I 3 Hours**

Topics in analysis chosen from inverse and implicit function theorems, differentiation, integration, infinite series, series of functions, and elementary functional analysis.

**Prerequisite(s):** MATH 337 with a minimum grade of C

*Recent Term(s) Offered: fall 2020; fall 2022*

**MATH 435 Partial Differential Equations 3 Hours**

Equations of first and second order; elliptic, hyperbolic and parabolic equations; Sturm-Liouville theory; applications to equations of mathematical physics using separation of variables and Fourier series.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 307 with a minimum grade of C and MATH 331 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; spring 2021; spring 2022*

**MATH 439 Topology I 3 Hours**

Introduction to topology including topics selected from: topological spaces, mappings, homeomorphisms, metric spaces, surfaces, knots, manifolds, separation properties, compactness and connectedness. Note: Permission of instructor may be required.

**Prerequisite(s):** MATH 317 with a minimum grade of C

*Recent Term(s) Offered: fall 2021; fall 2022*

**MATH 450 Complex Variables 3 Hours**

Complex number plane, analytic functions of a complex variable, integration, power series, calculus of residues, conformal representation, applications of analytic function theory.

**Prerequisite(s):** MATH 237 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; spring 2021; spring 2022*

**MATH 470 Introduction to Operations Research 3 Hours**

Principles and techniques of operations research including linear programming, integer programming, quality theory, sensitivity analysis, and dynamic programming.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 307 with a minimum grade of C

*Recent Term(s) Offered: None*

**MATH 473 Introduction to Graph Theory 3 Hours**

Fundamental concepts, key ideas and tools in graph theory, with an emphasis on proof methods, algorithms and applications. Techniques and tools are applied to practical optimization problems and other areas of mathematics and computer science. Note: Permission of instructor may be required.

**Prerequisite(s):** MATH 307 with a minimum grade of C and MATH 310 with a minimum grade of C

**Equivalent(s):** CS 473

*Recent Term(s) Offered: fall 2022*

**MATH 475 Selected Topics in Mathematics 1-3 Hours** (repeatable max of 6 hrs)

A consideration of special topics to acquaint the advanced undergraduate student with significant problems and developments of current interest in mathematics. Topics may vary each semester offered. Note: Permission of instructor required.

*Recent Term(s) Offered: spring 2020; spring 2021; fall 2021; fall 2022*

**MATH 482 Probability and Statistics II 3 Hours**

Multivariate probability distributions; sampling distributions, statistical inference; point and interval estimation, properties of estimators; hypothesis testing; regression and correlation; analysis of variance; non-parametric methods.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 382 with a minimum grade of C

*Recent Term(s) Offered: spring 2020; spring 2021; spring 2022*

**MATH 490 Seminar in Middle Grades Mathematics 1-3 Hours** (repeatable max of 3 hrs)

Designed to integrate the ideas and techniques students have encountered in the middle grades mathematics major. Students undertake independent investigations in mathematics. Papers and oral presentations are required. Note: Completion of at least 25 hours of mathematics courses with grades of C or better, required for the Middle Grades Mathematics Degree.

**Prerequisite(s):** (MATH 411 (may be taken concurrently) or MATH 421 (may be taken concurrently))

*Recent Term(s) Offered: spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022*

**MATH 497 Senior Seminar in Mathematical Economics 1 Hour**

This course is designed to integrate the ideas and techniques students have encountered in their work in mathematics and economics. Students will study research articles and/or undertake independent investigations in mathematical economics.

**Restriction(s):** Students with a semester level of Academy Junior, Academy Senior, Freshman, Junior or Sophomore may **not** enroll.

Enrollment is limited to students in Mathematical Economics (731)

**Equivalent(s):** ECON 497

*Recent Term(s) Offered: spring 2022*

**MATH 498 Senior Seminar 1-3 Hours** (repeatable max of 3 hrs)

Students will study articles in current mathematical journals or undertake independent investigations in mathematics. Written and oral presentations will be required. Note: Permission of instructor may be required.

**Prerequisite(s):** MATH 237 with a minimum grade of C and MATH 317 with a minimum grade of C

**Restriction(s):** Students with a semester level of Academy Junior, Academy Senior, Freshman, Junior or Sophomore may **not** enroll.

*Recent Term(s) Offered: spring 2020; fall 2020; spring 2021; fall 2021; spring 2022; fall 2022*