

# DEPARTMENT OF MATHEMATICS AND STATISTICS

501 Cafaro Hall  
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Welcome to the Youngstown State University Department of Mathematics and Statistics!

If you are attempting to register for a mathematics course and receive a registration error, please complete the Math Department Override Request Form (<https://forms.office.com/Pages/ResponsePage.aspx?id=F4pyOAeXSU-MmyecGkA4wbQmJL4wz7RjTBDyI9fB1-JUNVIlMVJKWTVBU1ZHM01aMkc00FcwOTRGRi4u>). Please contact the Department of Mathematics and Statistics at (330) 941-3302 with any questions. Please visit the "Placements and Pathways" tab for more information about mathematics placement.

The Department of Mathematics and Statistics builds scholarship in mathematics and exhibits leadership in the teaching and learning of mathematics. We maintain broad strength in mathematics and strengthen multidisciplinary collaborations that provide the foundations of scientific principles and prepare students for a technological society. We provide our students with a quality educational experience in mathematics that is responsive to the needs of all students while recognizing student achievement in mathematics and enthusiasm for creative thinking. Students may select mathematics as their major for the following degree program:

- Bachelor of Science (BS)

Students may concentrate in mathematics in the following degree program:

- Bachelor of Science in Education (BSEd)

In addition to satisfying general University requirements, all students majoring in mathematics must complete the following core courses:

COURSE	TITLE	S.H.
MATH 1571	Calculus 1	4
MATH 1572	Calculus 2	4
MATH 2673	Calculus 3	4
MATH 3715	Discrete Mathematics	3
MATH 3720	Linear Algebra and Matrix Theory	3
MATH 3721	Abstract Algebra 1	4
MATH 3751	Real Analysis 1	4
STAT 3743	Probability and Statistics	4
CSIS 2610	Programming and Problem-Solving	3
CSIS 2610L	Programming and Problem-Solving Lab	1
Proficiency in a language (foreign language, programming, or data analytics)		
One of the following:		2
MATH 4896	Senior Undergraduate Research Project	
MATH 4897H	Thesis	
STEM 4890	STEM Internship	

In addition, students must complete 12 semester hours in mathematics, statistics, or data analytics at the 3700-level or above, with at least two courses chosen from the 4800-level or higher. The total number of hours of mathematics is 40 semester hours.

In selecting appropriate courses, the student should consult a department advisor, since certain courses are recommended based upon whether the

student plans graduate study in mathematics or statistics, secondary school teaching, or a career in business, industry, or government. The following general recommendations are based upon these areas.

## Traditional Mathematics

In addition to the core, students seeking classical training in mathematics are recommended to take MATH 4822, MATH 4852, MATH 4880, and one additional 4800-level or higher course in mathematics. The minor course of study may be any discipline. Students will study the nature of mathematics in fields such as algebra, real analysis, complex analysis, and topology. Connections to, and generalizations of, earlier formulations of mathematical concepts will constantly occur. Generally, new results in mathematics are developed and proven by those with a Ph.D. in mathematics. Students planning to pursue a Ph.D. will be well prepared for graduate school with these courses.

## Applied Mathematics

Applied mathematics courses emphasize areas of mathematics used in government and industry. Students learn mathematical models for the study of physical and computational processes. Mathematical techniques are used to study uncertainty, scheduling, and decision theory. Many graduates find employment in consulting firms and large corporations where computing and mathematical problem solving skills are valued. Students are also prepared to pursue advanced degrees in applied mathematics.

In addition to the core, students interested in applied mathematics are recommended to take MATH 3705, 3745, 4847, 4826, 4855, 5835, 5845, or 5860 and complete a recognized minor in any discipline. Suggested minors include statistics, computer science, engineering, physics, geology, chemistry, biology, or economics.

## Statistics

Statistical techniques are utilized in many fields of research such as medicine, biology, business, and sociology. Statisticians learn proper methodology for collecting, summarizing, and interpreting data subject to sampling variability. The increase in affordable computing and the ease of statistical software have placed statistical expertise in demand. Generally, students interested in statistics pursue further study at the graduate level, but positions are available for students upon completion of a bachelor's degree.

In addition to the core, students interested in statistics are recommended to fulfill their upper-level course requirements with statistics courses and complete a minor in statistics.

## Actuarial Mathematics

Students interested in using mathematics and statistics to quantify risk and develop models to better predict and study risk should consider actuarial mathematics. Actuaries work for insurance companies, investment and consulting firms, as well as the government and seek ways to manage risk and avoid potential exposure to excessive risk. Actuaries assess pension plans, mortality rates, and accident rates. Students will study the mathematical and statistical foundations of actuarial models as they prepare for the examination sequence to become a licensed actuary.

In addition to the core, students interested in actuarial mathematics are recommended to take STAT 4843, STAT 4844, and STAT 5802 and complete a minor in actuarial science.

## Accelerated 4+1 Program

Undergraduate students can apply for admission into the accelerated program for the MS in Mathematics after completing 78 undergraduate semester hours with a GPA of 3.3 or higher. After being admitted to the accelerated MS program, students can take a maximum of nine semester hours of graduate coursework that can count toward both a bachelor's and master's degree from the Department of Mathematics and Statistics. The courses chosen to count for both undergraduate and graduate coursework must be approved by the Graduate Executive Committee within the Department upon admission into the

program. An additional six hours of graduate coursework can be completed as an undergraduate and used exclusively for graduate credit. This allows the student to graduate with a master's degree with one year of additional full-time study beyond the bachelor's degree.

#### Chair

**Thomas P. Wakefield**, Ph.D., Professor, Chair

#### Professor

**Jozsi Z. Jalics**, Ph.D., Professor

**G. Jay Kerns**, Ph.D., Professor

**Lucy Xiaojing Kerns**, Ph.D., Associate Professor

**Thomas L. Madsen**, Ph.D., Associate Professor

**Nguyet Thi Nguyen**, Ph.D., Associate Professor

**Anita C. O'Mellan**, Ph.D., Professor

**Alicia Prieto Langarica**, Ph.D., Professor

**Thomas Smotzer**, Ph.D., Professor

**Jamal K. Tartir**, Ph.D., Professor

**Padraic ("Paddy") W. Taylor**, Ph.D., Associate Professor

#### Lecturer

**Lori A. Carlson**, M.S., Senior Lecturer

**Emily Dolsak**, M.S., Senior Lecturer

**Michele Fredrick-Jacobson**, M.S., Lecturer

**Sepideh Khavari**, M.S., Senior Lecturer

**Alayne Leone**, M.S., Senior Lecturer

## Majors

- BS in Mathematics (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/bs-mathematics-traditional-mathematics-track/>)

## Minors

- Mathematics Minor (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/mathematics-minor/>)
- Statistics Minor (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/statistics-minor/>)
- Biomathematics Minor (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/biomathematics-minor/>)
- Actuarial Science Minor (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/actuarial-science-minor/>)
- Data Analytics Minor (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/data-analytics-minor/>)

## Certificates

- Certificate in Data Analytics (<http://catalog.yzu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/departments-mathematics-statistics/certificate-data-analytics/>)

## Mathematics

### MATH 1500 Mathematics Support 0-3 s.h.

This course provides additional support to students in their mathematics courses. Does not count toward the degree. May be repeated. Grading is ABC/NC.

**Prereq.:** Permission of the Department of Mathematics and Statistics.

### MATH 1500R Mathematics Support Calculus 2 1-3 s.h.

This course is for students in the algebra pathway (mainly pre-STEM and pre-business) who wish to improve their mathematics placement and skills in desired areas of mathematics. Topics covered are uniquely determined by the student's initial placement assessment. Does not count toward the degree. May be repeated. Grading is ABC/NC.

### MATH 1510 College Algebra 4 s.h.

This course is primarily intended to prepare STEM students (along with MATH 1511) for MATH 1552, 1570 or 1571. Topics include real numbers, equations and inequalities, linear, quadratic, polynomial, exponential, and logarithmic functions, graphing techniques, systems of equations, and applications. The course fulfills the general education requirements for mathematics.

**Prereq.:** YSU Math Placement Level 35 or higher .

**Gen Ed:** Mathematics.

### MATH 1510C College Algebra with Co-requisite Support 6 s.h.

This course is primarily intended to prepare STEM students (along with MATH 1511C) for MATH 1552, 1570 or 1571. Topics include real numbers, equations and inequalities, linear, quadratic, polynomial, exponential, and logarithmic functions, graphing techniques, systems of equations, and applications. It includes corequisite support for students requiring remediation in mathematics while studying college algebra. Emphasis will be placed on prerequisite skills needed for college algebra as well as just in time review through the use of appropriate technology. The course fulfills the general education requirements for mathematics.

**Prereq.:** YSU Math Placement Level 20.

**Gen Ed:** Mathematics.

### MATH 1511 Trigonometry 3 s.h.

This course, along with MATH 1510 is primarily intended to prepare STEM students for MATH 1570 or MATH 1571. Topics include algebraic structure and graphs of trigonometric functions and inverse trigonometric functions, angle measurements, similar triangles, trigonometric identities, vectors, complex numbers, polar coordinates and solving trigonometric equations with applications.

**Prereq.:** YSU Math Placement Level 35 or higher.

**Gen Ed:** Mathematics.

### MATH 1511C Trigonometry with Co-requisite Support 4 s.h.

This course, along with MATH 1510C is primarily intended to prepare STEM students for MATH 1570 or MATH 1571. Topics include algebraic structure and graphs of trigonometric functions and inverse trigonometric functions, angle measurements, similar triangles, trigonometric identities, vectors, complex numbers, polar coordinates and solving trigonometric equations with applications. This course includes support for students requiring remediation in mathematics while they are studying trigonometry. Emphasis will be placed on prerequisite skills needed for trigonometry as well as just in time review through the use of appropriate technology.

**Prereq.:** YSU Math Placement Test Level 20 and a grade of C or better in MATH 1510 or MATH 1510C .

**Gen Ed:** Mathematics.

**MATH 1513 Algebra and Transcendental Function 5 s.h.**

Function concepts including trigonometric, exponential, and logarithmic functions. Application problems and graphing. Supplemental topics.

**Prereq.:** Math Placement Level 45 or higher.

**Gen Ed:** Mathematics.

**MATH 1552 Applied Business Calculus 4 s.h.**

Apply functions and linear systems to business including use of technology; mathematics of finance and an introduction to limits, derivatives and integrals with business, management, economics, life science and social science applications. Credit will not be given to students who have completed MATH 1570, 1571, 1571H, 1581, 1581H, or 1585H.

**Prereq.:** One of Math 1510, Math 1510C, or Math 1513 with grade of "C" or better or at least Level 45 on the YSU Mathematics Placement Test.

**Gen Ed:** Mathematics.

**MATH 1564 Foundations of Middle School Mathematics 1 4 s.h.**

Conceptual foundations of topics from number theory, operations, functions, algebra, and data analysis. Emphasis on multiple approaches and representations, problem solving, and communication of mathematical reasoning. Includes inquiry-based experiences with manipulatives and computing technology.

**Prereq.:** Level 35 on the Mathematics Placement Test or C or better in either MATH 1510 or MATH 1510C.

**MATH 1570 Applied Calculus 1 4 s.h.**

The elements of differential and integral calculus, with emphasis on applications. Analytical geometry, differentiation and integration techniques and series representations. Introduction to differential equations, transform calculus, and Fourier analysis. This is a basic methods course particularly adapted for those who require applied topics in mathematics. Not applicable toward the Mathematics major. Credit will not be given for both MATH 1552 and MATH 1570.

**Prereq.:** At least Level 70 on the YSU Mathematics Placement Test or "C" or better in either MATH 1510 and MATH 1511, MATH 1510C and MATH 1511C, or MATH 1513.

**Gen Ed:** Mathematics.

**MATH 1571 Calculus 1 4 s.h.**

This course is an introduction to calculus. The main concepts to be studied are limits, continuity, rates of change, derivatives, integrals and applications.

**Prereq.:** At least Level 70 on the YSU Mathematics Placement Test or C or better in either MATH 1510 and MATH 1511, MATH 1510C and MATH 1511C, or MATH 1513.

**Gen Ed:** Mathematics.

**MATH 1571H Honors Calculus 1 4 s.h.**

A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.

**Prereq.:** MATH 1513, minimum grade of "C", or MATH 1510 and MATH 1511, minimum grade of "C" in both courses, or at least Level 70 on the Mathematics Placement Test.

**Gen Ed:** Mathematics.

**MATH 1572 Calculus 2 4 s.h.**

A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.

**Prereq.:** C or better in MATH 1571, MATH 1571H, MATH 1581, MATH 1581H, or MATH 1585H.

**MATH 1572H Honors Calculus 2 4 s.h.**

A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.

**Prereq.:** C or better in MATH 1571, MATH 1571H, MATH 1581, MATH 1581H, or MATH 1585H.

**MATH 1581 Calculus for the Health Sciences 1 4 s.h.**

This is the first course in a two-semester sequence of calculus courses intended for students majoring in the biological or environmental sciences and/or preparing for admission to medical, pharmaceutical, dental, veterinary, or other life-science-related professional schools. We will cover definitions of trigonometric functions, solving trigonometric equations, functions, limits and derivatives, exponential and logarithmic functions, and applications.

**Prereq.:** At least Level 70 on the YSU Mathematics Placement Test or "C" or better in MATH 1510/MATH 1510C and MATH 1511/MATH 1511C or "C" or better in MATH 1513.

**Gen Ed:** Mathematics.

**MATH 1581H Honors Calculus for the Health Sciences 1 4 s.h.**

This is the first course in a two-semester sequence of calculus courses intended for students majoring in the biological or environmental sciences and/or preparing for admission to medical, pharmaceutical, dental, veterinary, or other life-science-related professional schools. We will cover definitions of trigonometric functions, solving trigonometric equations, functions, limits and derivatives, exponential and logarithmic functions, and applications.

**Prereq.:** At least Level 70 on the YSU Mathematics Placement Test or "C" or better in MATH 1510/MATH 1510C and MATH 1511/MATH 1511C or "C" or better in MATH 1513.

**Gen Ed:** Mathematics.

**MATH 1582 Calculus for the Health Sciences 2 4 s.h.**

This is the second course in a two-semester sequence of calculus courses intended for students majoring in the biological or environmental sciences and/or preparing for admission to medical, pharmaceutical, dental, veterinary, or other life-science-related professional schools. We will cover indefinite and definite integrals, probability, functions of several variables, least squares, differential equations.

**Prereq.:** "C" or better in MATH 1571, MATH 1571H, MATH 1581, or MATH 1581H.

**Gen Ed:** Mathematics.

**MATH 1582H Honors Calculus for the Health Sciences 2 4 s.h.**

This is the second course in a two-semester sequence of calculus courses intended for students majoring in the biological or environmental sciences and/or preparing for admission to medical, pharmaceutical, dental, veterinary, or other life-science-related professional schools. We will cover indefinite and definite integrals, probability, functions of several variables, least squares, differential equations.

**Prereq.:** "C" or better in MATH 1571, MATH 1571H, MATH 1581, or MATH 1581H.

**Gen Ed:** Mathematics.

**MATH 1585H Honors Accelerated Calculus 1 5 s.h.**

A sequence of honors courses in analytical geometry and calculus which cover essentially the same material as MATH 1571, 1572, 2673, in two semesters instead of three. A detailed study of limits, derivatives, and integrals of functions of one and several variables and their applications. This sequence will be offered at most once during each academic year.

**Prereq.:** ACT math subscore of 32, AP Calculus score of 4 or higher, or at least one unit of high school calculus with a score of 28 or higher on placement exam or instructor permission.

**Coreq.:** MATH 1586H.

**Gen Ed:** Mathematics.

**MATH 1586H Honors Calculus Laboratory 1 1 s.h.**

Introduction to mathematical modeling of topics covered in calculus. Emphasizes the use of technology such as computer algebra systems, technical document processing, and graphics software for solving problems and reporting solutions.

**Coreq.:** MATH 1585H.

**MATH 2623 Quantitative Reasoning 3 s.h.**

Mathematics models emphasizing basic ideas in mathematics and statistics, stressing concept formation rather than manipulative skills.

**Prereq.:** YSU Mathematics Placement Level 15 or higher.

**Gen Ed:** Mathematics.

**MATH 2623C Quantitative Reasoning with Co-Requisite Support 5 s.h.**

Mathematics models emphasizing basic ideas in mathematics and statistics, stressing concept formation rather than manipulative skills. This course includes corequisite support for students requiring remediation in mathematics while studying quantitative reasoning. Emphasis for the support will be placed on prerequisite skills needed for MATH 2623 as well as just in time review through the use of appropriate technology.

**Gen Ed:** Mathematics.

**MATH 2623H Honors Quantitative Reasoning 3 s.h.**

Mathematics models emphasizing basic ideas in mathematics and statistics, stressing concept formation rather than manipulative skills.

**Prereq.:** at least Level 20 on the Mathematics Placement Test or Level 10 on Mathematics Placement Test and concurrent enrollment in MATH 2623C.

**Gen Ed:** Mathematics.

**MATH 2661 Mathematics for Elementary Teachers 1 4 s.h.**

A conceptual development of mathematics topics underlying today's Pre-K-grade 5 curriculum (Number, Operations, and Algebraic Thinking). Emphasis on multiple approaches, problem solving, and communication of mathematics. Incorporates manipulatives, technology, and classroom activities developmentally appropriate for early and elementary children.

**Prereq.:** At least Level 15 on the Mathematics Placement Test.

**Gen Ed:** Mathematics.

**MATH 2661C Mathematics for Elementary Teachers I with Co-Requisite Support 6 s.h.**

A conceptual development of mathematics topics underlying today's Pre-K-grade 5 curriculum (Number, Operations, and Algebraic Thinking). Emphasis on multiple approaches, problem solving, and communication of mathematics. Incorporates manipulatives, technology, and classroom activities developmentally appropriate for early and elementary children. This course includes corequisite support for students requiring remediation in mathematics. Emphasis will be placed on prerequisite skills needed for Algebra, Number and Operations, and Quantity topics as well as just in time review through the use of appropriate technology.

**Prereq.:** Math Placement Level 10 or higher.

**MATH 2662 Mathematics for Elementary Teachers 2 4 s.h.**

A conceptual development of mathematics topics underlying today's Pre-K-grade 5 curriculum (Decimals, Ratios, Percents, Geometry, Measurement, Probability & Statistics). Emphasis on multiple approaches, problem solving, and communication of mathematics. Incorporates manipulatives, technology, and classroom activities developmentally appropriate for early and elementary children.

**Prereq.:** C or better in either MATH 2661 or MATH 2661C.

**Gen Ed:** Mathematics.

**MATH 2665 Foundations of Middle School Mathematics 2 4 s.h.**

Conceptual foundations of topics from geometry, measurement, and probability. Emphasis on multiple approaches and representations, problem solving, and communication of mathematical reasoning. Includes inquiry-based experiences with manipulatives and computing technology.

**Prereq.:** Level 35 on the Mathematics Placement Test or C or better in either MATH 1510 or MATH 1510C.

**Gen Ed:** Mathematics.

**MATH 2670 Applied Calculus 2 5 s.h.**

The elements of differential and integral calculus, with emphasis on applications. Analytical geometry, differentiation and integration techniques and series representations. Introduction to differential equations, transform calculus, and Fourier analysis. This is a basic methods course particularly adapted for those who require applied topics in mathematics. Not applicable toward the Mathematics major.

**Prereq.:** Grade of "C" or better in MATH 1570 or MATH 1571.

**Gen Ed:** Mathematics.

**MATH 2673 Calculus 3 4 s.h.**

A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.

**Prereq.:** MATH 1572 with a "C" or better.

**MATH 2673H Honors Calculus 3 4 s.h.**

A sequence of integrated courses in analytic geometry and calculus. A detailed study of limits, derivatives, and integrals of functions of one and several variables with applications.

**Prereq.:** MATH 1572 with a "C" or better.

**MATH 2686H Honors Accelerated Calculus 2 5 s.h.**

A sequence of honors courses in analytical geometry and calculus which cover essentially the same material as MATH 1571, 1572, 2673, in two semesters instead of three. A detailed study of limits, derivatives, and integrals of functions of one and several variables and their applications. This sequence will be offered at most once during each academic year.

**Prereq.:** "C" or better in MATH 1585H.

**Coreq.:** MATH 2687H.

**Gen Ed:** Mathematics.

**MATH 2687H Honors Calculus Laboratory 2 1 s.h.**

Introduction to mathematical modeling of topics covered in calculus. Emphasizes the use of technology such as computer algebra systems, technical document processing, and graphics software for solving problems and reporting solutions.

**Coreq.:** MATH 2686H.

**MATH 3702 Problem Solving Techniques for Secondary Mathematics 3 s.h.**

Approaches to and practice with problem solving with examples from a broad spectrum of mathematics. Emphases include problems at the level of the Ohio Assessment for Educators (OAE) examination for integrated mathematics and problems suitable for high school contests. Not applicable to the mathematics major or minor.

**Prereq.:** Limited to TELS majors with MATH 1572, 1572H or MATH 1585H or consent of instructor.

**MATH 3705 Differential Equations 3 s.h.**

Methods and theory of solving differential equations with applications. Existence, uniqueness. First order equations. Higher order linear equations. Introduction to partial differential equations and boundary value problems, including Laplace's equation.

**Prereq.:** C or better in one of MATH 2673, MATH 2673H, or MATH 2686H.

**MATH 3705H Honors Differential Equations 3 s.h.**

Methods and theory of solving differential equations with applications. Existence, uniqueness. First order equations. Higher order linear equations. Introduction to partial differential equations and boundary value problems, including Laplace's equation.

**Prereq.:** C or better in one of MATH 2673, MATH 2673H, or MATH 2686H.

**MATH 3715 Discrete Mathematics 3 s.h.**

A course in discrete mathematical structures to prepare students for advanced courses. Topics include set theory, functions and relations, logic and quantifiers, truth tables and Boolean expressions, induction and other techniques of proof, and graphs. Credit will not be given for both CSCI 3710 and MATH 3715.

**Prereq.:** C or better in either MATH 1572, MATH 1572H, or MATH 1585H.

**MATH 3715H Honors Discrete Mathematics 3 s.h.**

A course in discrete mathematical structures to prepare students for advanced courses. Topics include set theory, functions and relations, logic and quantifiers, truth tables and Boolean expressions, induction and other techniques of proof, and graphs. Credit will not be given for both CSCI 3710 and MATH 3715.

**Prereq.:** C or better in either MATH 1572, MATH 1572H, or MATH 1585H.

**MATH 3718 Linear Algebra and Discrete Mathematics for Engineers 3 s.h.**

This introduction to linear algebra and discrete mathematics covers the following topics: systems of linear equations, logic and proof, matrix algebra, determinants, vector spaces, eigenvalues and eigenvectors, set theory, and counting. The course does not count toward the mathematics major. Credit will not be given for MATH 3718 and both MATH 3715 and MATH 3720.

**Prereq.:** "C" or better in MATH 1572 or MATH 1572H.



**MATH 3720 Linear Algebra and Matrix Theory 3 s.h.**

Matrices; matrix operations; linear transformations; applications.

**Prereq.:** "C" or better in either MATH 1570, MATH 1571, MATH 1571H, MATH 1581, MATH 1581H, or MATH 1585H.

**MATH 3720H Honors Linear Algebra and Matrix Theory 3 s.h.**

Matrices; matrix operations; linear transformations; applications.

**Prereq.:** "C" or better in either MATH 1572, MATH 1572H, or MATH 1585H.

**MATH 3721 Abstract Algebra 1 4 s.h.**

Introduction to abstract algebra investigating fundamental concepts in group and ring theory. Topics include groups, subgroups, cyclic groups, permutation groups, cosets, direct products, homomorphisms, factor groups, rings, integral domains and polynomial rings.

**Prereq.:** "C" or better in MATH 3720 and either MATH 3715 or CSCI 3710.

**MATH 3745 Topics in Mathematical Modeling 3 s.h.**

This course exposes students to methods of mathematical modeling through applications. Tools used to develop, refine, test, and present mathematical models will be discussed. Topics covered and projects undertaken may vary with each course offering and are designed to expose students to the types of problems modeled by applied mathematicians working in business, government, industry, or research. Course may be repeated depending on projects or topics presented.

**Prereq.:** "C" or better in MATH 2673, MATH 2673H, or MATH 2686H or permission of the instructor.

**MATH 3745H Honors Topics in Mathematical Modeling 3 s.h.**

3745h. This course exposes students to methods of mathematical modeling through applications. Tools used to develop, refine, test, and present mathematical models will be discussed. Topics covered and projects undertaken may vary with each course offering and are designed to expose students to the types of problems modeled by applied mathematicians working in business, government, industry, or research. Course may be repeated depending on projects or topics presented.

**Prereq.:** "C" or better in MATH 2673, MATH 2673H, or MATH 2686H or permission of the instructor.

**MATH 3750 History of Mathematics 3 s.h.**

A survey of the historical development of mathematics.

**Prereq. or Coreq.:** MATH 3715.

**MATH 3750H Honors History of Mathematics 3 s.h.**

A survey of the historical development of mathematics.

**Prereq. or Coreq.:** MATH 3715.

**MATH 3751 Real Analysis 1 4 s.h.**

Introduction to the properties of the real number system and metrics and metric properties, with critical analysis of limits, continuity, differentiability, integration, and other fundamental concepts underlying the calculus.

**Prereq.:** "C" or better in MATH 3715 or CSCI 3710 and one of MATH 2673, MATH 2673H, or MATH 2686H.

**MATH 3767 Algebra/Geometry for Middle School Teachers 1 4 s.h.**

MATH 3767, MATH 3768 is an integrated, conceptual, and function-centered approach to the foundations of algebra, geometry, and trigonometry for preservice middle childhood mathematics specialists. Emphasis on multiple approaches and representations, problem solving, and communication of mathematical reasoning. Includes inquiry-based experiences. MATH 3767 focuses on conceptual foundations of algebra and parts of coordinate geometry. Not applicable to the mathematics major.

**Prereq.:** Level 35 on the Mathematics Placement Test or C or better in either MATH 1510 or MATH 1510C.

**MATH 3768 Algebra/Geometry for Middle School Teachers 2 4 s.h.**

MATH 3767 and MATH 3768 is an integrated, conceptual, and function-centered approach to the foundations of algebra, geometry, and trigonometry for preservice middle childhood mathematics specialists. Emphasis on multiple approaches and representations, problem solving, and communication of mathematical reasoning. Includes inquiry-based experiences. MATH 3768 focuses on synthetic, analytic and transformational geometry. Not applicable to the mathematics major.

**Prereq.:** C or better in MATH 2665 and Level 35 on the Mathematics Placement Test or C or better in MATH 2665 and C or better in either MATH 1510 or MATH 1510C.

**MATH 3795 Topics in Mathematics 1-4 s.h.**

The study of a mathematical topic or the development of a special area of mathematics. May be repeated once.

**Prereq.:** 'C' or better in a general education mathematics course and permission of the instructor.

**MATH 4822 Abstract Algebra 2 3 s.h.**

A continuation of MATH 3721 with special emphasis on fields. Additional topics in pure or applied algebra.

**Prereq.:** MATH 3721 or equivalent.

**MATH 4823 Abstract Algebra 3 3 s.h.**

This course introduces advanced topics in field theory. Topics may include principal ideal domains, irreducibility, quotient rings, algebraic extensions, finite fields, splitting fields, and the Galois group.

**Prereq.:** MATH 4822.

**MATH 4826 Advanced Linear Algebra 3 s.h.**

The study of more advanced topics in linear algebra, including abstract vector spaces and linear transformations. May include applications of linear algebra.

**Prereq.:** MATH 3721.

**MATH 4830 Foundations of Geometry 3 s.h.**

The development of Euclidean and non-Euclidean geometries from postulate systems.

**Prereq.:** "C" or better in MATH 3715.

**MATH 4832 Euclidean Transformations 3 s.h.**

General properties of functions and transformations; isometries and transformations of the Euclidean plane; the complex plane, its geometry and subfields; transformational, analytical, and vector approaches to Euclidean geometry; connections to other branches of mathematics and applications.

**Prereq.:** "C" or better in MATH 3720 and MATH 4830.

**MATH 4847 Introduction to Applied Mathematics 3 s.h.**

This course surveys topics in applied mathematics and may include scaling, perturbation methods, stationary phase analysis, multi-scale asymptotics, transform methods, Green's functions, discrete models, the calculus of variations, or optimization.

**Prereq.:** C or better in MATH 2673.

**MATH 4852 Real Analysis 2 3 s.h.**

This course covers topics in the analysis of functions, mainly of several variables, and may include uniform convergence of sequences of functions and some consequences, functions on  $n$ -space, derivatives in vector spaces, and results such as the mean value theorem, Taylor's formula, inverse mapping theorem, and the implicit mapping theorem.

**Prereq.:** MATH 3720 and MATH 3751 or equivalent.

**MATH 4855 Ordinary Differential Equations 3 s.h.**

A second course in differential equations with emphasis on nonlinear problems and qualitative methods or on boundary value problems. Topics are chosen from: proofs of fundamental theorems, phase plane analysis, limit cycles and the Poincare-Bendixon theorem, biological models, stability via Liapunov functions, asymptotic methods, and boundary value problems.

**Prereq.:** MATH 3705 and MATH 3720.

**MATH 4857 Partial Differential Equations 3 s.h.**

Introduction to partial differential equations (PDE) including solution techniques and applications. Classifications of the basic types of PDE's (hyperbolic, parabolic and elliptic) and dependence on boundary and initial conditions. Topics include Fourier series, integral transforms (Fourier, Laplace), and applications in vibrations, electricity, heat transfer, fluids or other selected topics.

**Prereq.:** MATH 3705 and MATH 3720.

**MATH 4869 Functions, Calculus, and Applications for Middle School Teachers 3 s.h.**

Polynomial and exponential functions, limits, derivatives, integrals, and applications. Interpretation of slope and area in graphs of functions from applied settings. Applications of limits to the derivations of geometric formulas. Relations between tables, graphs, and the symbolic representation of functions.

**Prereq.:** "C" or better in MATH 3767 or consent of instructor.

**MATH 4870 Mathematics Concepts for Middle School Teachers 3 s.h.**

Problem solving from a broad spectrum of mathematics topics (Number Sense and Operations; Algebra, Functions, and Calculus; Measurement and Geometry; Statistics, Probability, and Discrete Mathematics) designed to prepare future middle school mathematics teachers to address Common Core Standards. May be repeated 2 times.

**Prereq.:** MATH 1564, 2665, MATH 3767, MATH 3768, MATH 4869, and either STAT 2601, STAT 2625 or STAT 2625C.

**MATH 4872 Teaching Mathematics in Secondary Schools 3 s.h.**

Techniques and materials for effective teaching of secondary school mathematics will be discussed. Not applicable toward the mathematics major or minor. May be repeated once.

**Prereq.:** Limited to AYA Integrated Mathematics majors who obtained a C or better in MATH 1572, 1572H or MATH 1585H or consent of instructor.

**MATH 4875 Complex Variables 3 s.h.**

Complex numbers and their geometric representation, analytic functions of a complex variable, contour integration, Taylor and Laurent series, residues and poles, conformal mapping.

**Prereq.:** MATH 3751 or equivalent.

**MATH 4880 Introduction to Topology 3 s.h.**

An introduction to the basic concepts of general topology: compactness, connectedness, and continuity in topological spaces.

**Prereq.:** MATH 3721 and MATH 3751.

**MATH 4882 Mathematical Biology Research 1-3 s.h.**

Introduction to research in mathematical biology through an interdisciplinary study of a topic in biology and mathematics. May be repeated once. Grading is Traditional/PR. Listed also as BIOL 4882.

**Prereq.:** MATH 1571 or permission of the instructor.

**MATH 4896 Senior Undergraduate Research Project 2 s.h.**

Individualized study of a topic in mathematics culminating in a written report and an oral presentation at a national or regional meeting or a local seminar. May be repeated once.

**Prereq.:** 24 s.h. of mathematics applicable to the mathematics major including either MATH 3721 or MATH 3751 and permission of the department chairperson.

**Gen Ed:** Capstone.

**MATH 4897H Thesis 2 s.h.**

Individualized study of a topic in mathematics culminating in a written report and an oral presentation at a national or regional meeting or a local seminar.

**Prereq.:** 24 semester hours of mathematics applicable to the mathematics major including both MATH 3721 and MATH 3751 and permission of the department chairperson.

**Gen Ed:** Capstone.

**MATH 5821 Topics in Abstract Algebra 4 s.h.**

A course in abstract algebra aimed at developing a broad understanding of the subject. Credit will not be given for both MATH 3721 and MATH 5821.

**Prereq.:** Permission of graduate coordinator or department chair.

**MATH 5828 Number Theory 3 s.h.**

A study of congruences, Diophantine equations, quadratic residues, special number theory functions, and selected applications.

**Prereq.:** MATH 3721.

**MATH 5835 Introduction to Combinatorics and Graph Theory 3 s.h.**

The pigeonhole principle; permutations, combinations, the binomial theorem; the inclusion-exclusion principle; recurrence relations; graphs and digraphs, paths and cycles, trees, bipartite graphs and matchings.

**Prereq.:** C or better in either MATH 3715 or CSCI 3710 and C or better in MATH 3720.

**MATH 5845 Operations Research 3 s.h.**

An introduction to operations research with emphasis on mathematical methods. Topics may include: linear programming, sensitivity analysis, duality theory, transportation problems, assignment problems, transshipment problems, and network problems.

**Prereq.:** MATH 3715 and MATH 3720.

**MATH 5849 Computational Methods for Problems in the Physical Sciences 3 s.h.**

Use of contemporary computational approaches to conduct research in the physical sciences using Matlab and supercomputers. Algorithm development and formal exercise tasks may vary depending on the stage of the course, student abilities, and the topic under consideration. Provides application of the techniques discussed in the class to real world situations.

**Prereq.:** MATH 3705 and PHYS 2610.

**Cross-Listed:** CSCI 5849 and PHYS 5849.

**MATH 5851 Topics in Analysis 4 s.h.**

A course in analysis aimed at developing a broad understanding of the subject. Credit will not be given for both MATH 3751 and MATH 5851.

**Prereq.:** Permission of graduate coordinator or department chair.

**MATH 5860 Numerical Analysis 1 3 s.h.**

The theory and techniques of numerical computation. The solution of a single equation, interpolation methods, numerical differentiation and integration, direct methods for solving linear systems.

**Prereq.:** MATH 3720 and CSIS 2610 and MATH 2673, MATH 2673H, or MATH 2686H.

**MATH 5861 Numerical Analysis 2 3 s.h.**

Numerical methods of initial-value problems, eigenvalue problems, iterative methods for linear and nonlinear systems of equations, and methods involving least squares, orthogonal polynomials, and fast Fourier transforms.

**Prereq.:** MATH 5860 or equivalent.

**MATH 5895 Selected Topics in Mathematics 2-3 s.h.**

The study of a standard mathematical topic in depth or the development of a special area of mathematics. May be repeated twice.

**Prereq.:** 24 s.h. of mathematics applicable to the mathematics major including either MATH 3721 or MATH 3751.

## Statistics

**STAT 2601 Introductory Statistics 3 s.h.**

Designed for students from different disciplines who desire an introduction to statistical reasoning. Topics include collecting and summarizing data, concepts of randomness and sampling, statistical inference and reasoning, correlation and regression. Credit will not be given for both STAT 2601 and STAT 2625.

**Prereq.:** "C" or better in MATH 1552 or Level 35 or higher on YSU Mathematics Placement Test.

**Gen Ed:** Mathematics.

**STAT 2625 Statistical Literacy and Critical Reasoning 4 s.h.**

An introduction to statistics and its applications. Topics include descriptive statistics, experimental design, probability sampling distribution, statistical inference, correlation and regression. Emphasis on applications, critical reasoning, and data analysis using statistical software. Credit will not be given for both STAT 2601 and STAT 2625.

**Prereq.:** At least Mathematics Placement Level 15.

**Gen Ed:** Mathematics.

**STAT 2625C Statistical Literacy and Critical Reasoning with Co-Requisite Support 6 s.h.**

An introduction to statistics and its applications. Topics include descriptive statistics, experimental design, probability, sampling distribution, statistical inference, correlation and regression. Emphases are on applications, critical reasoning, and data analysis using statistical software. Includes co-requisite support for basic algebra skills required to be successful in the course.

**Gen Ed:** Mathematics.

**STAT 3717 Statistical Methods 4 s.h.**

Probability and statistics designed for students majoring in the natural sciences. Topics include descriptive statistics, probability, estimation, testing hypotheses, analysis of variance, regression and nonparametric statistics. Use of personal computers with computer software will be required. Credit will not be given for both STAT 3717 and STAT 3743.

**Prereq.:** "C" or better in one of MATH 1552, MATH 1570, MATH 1571, MATH 1571H, MATH 1581, MATH 1581H, MATH 1585H or equivalent.

**STAT 3717H Honors Statistical Methods 4 s.h.**

Probability and statistics designed for students majoring in the natural sciences. Topics include descriptive statistics, probability, estimation, testing hypotheses, analysis of variance, regression and nonparametric statistics. Use of personal computers with computer software will be required. Credit will not be given for both STAT 3717 and STAT 3743.

**Prereq.:** "C" or better in one of MATH 1552, MATH 1570, MATH 1571, MATH 1571H, MATH 1581, MATH 1581H, MATH 1585H or equivalent.

**STAT 3743 Probability and Statistics 4 s.h.**

A calculus-based probability and statistics course. Topics include descriptive statistics, probability models and related concepts and applications, statistical estimation, and hypothesis testing. Credit will not be given for both STAT 3717 and STAT 3743.

**Prereq.:** "C" or better in MATH 1572, MATH 1572H, MATH 1581, MATH 1581H or MATH 1585H.

**STAT 3743H Honors Probability and Statistics 4 s.h.**

A calculus-based probability and statistics course. Topics include descriptive statistics, probability models and related concepts and applications, statistical estimation, and hypothesis testing. Credit will not be given for both STAT 3717 and STAT 3743/H.

**Prereq.:** "C" or better in MATH 1572, MATH 1572H, MATH 1581, MATH 1581H or MATH 1585H.

**STAT 4817 Applied Statistics 3 s.h.**

Application of regression, survey sampling, analysis of variance, design and analysis of experiments, and related topics.

**Prereq.:** STAT 3717 or STAT 3743 or equivalent.

**STAT 4843 Theory of Probability 3 s.h.**

The mathematical foundation of probability theory including the study of discrete and continuous distributions. Other topics selected from limit theorems, generating functions, stochastic processes, and applications.

**Prereq.:** STAT 3743 and one of MATH 2673 or MATH 2686H or consent of department chairperson.

**STAT 4844 Theory of Statistics 3 s.h.**

The mathematical theory of statistical inferences including likelihood principle, sufficient statistics, theory of statistical estimation, hypothesis testing and related topics.

**Prereq.:** STAT 4843.

**STAT 4848 Applied Regression Time Series 3 s.h.**

Statistical methods for regression and time series analysis. Topics include applied linear regression with model fitting and diagnostics, data analysis, and forecasting with time series models.

**Prereq.:** STAT 3717 or STAT 3743.

**STAT 4849 Design of Experiments 3 s.h.**

The objective of this course is to learn how to plan, design and conduct experiments efficiently, and apply statistical techniques on resulting data to obtain conclusions. Topics include introduction of experiments, complete randomized designs, blocking designs, factorial designs, nested designs, and random effects models.

**Prereq.:** STAT 4817 or STAT 6940 or equivalent.

**STAT 4896 Statistical Project 2 s.h.**

Individualized study of a topic in statistics culminating in a written report and an oral presentation. May be repeated once.

**Prereq.:** STAT 4817 and permission of chairperson.

**Gen Ed:** Capstone.

**STAT 5802 Mathematical Interest Theory 3 s.h.**

Mathematical theory and techniques in analysis of interest. Topics include measurement of interest, force of interest, annuities, amortization, pricing of investment products, and applications to actuarial sciences.

**Prereq.:** C or better in one of MATH 1552, MATH 1570, MATH 1571, MATH 1571H, h.

**STAT 5811 SAS Programming for Data Analytics 3 s.h.**

An introduction to SAS programming for data analytics. Topics include using SAS for data processing, manipulation, visualization, reporting and statistical analysis. The objective is for students to develop statistical computing skills for problem solving and decision making. Also listed as ECON 5861.

**Prereq.:** STAT 3717 or STAT 3743 or STAT 2601 or ECON 3790 or equivalent.

**STAT 5814 Statistical Data Mining 3 s.h.**

A systematic introduction to data mining with emphasis on various data mining problems and their solutions. Topics include data mining processes and issues, exploratory data analysis, supervised and unsupervised learning, classification, and prediction methods.

**Prereq.:** STAT 3717 or STAT 3743, or consent of department chairperson.

**STAT 5819 Bayesian Statistics 3 s.h.**

An introduction to the Bayesian approach to statistical inference for data analysis in a variety of applications. Data analysis using statistical software will be emphasized. Topics include: comparison of Bayesian and frequentist methods, Bayesian model specification, prior specification, basics of decision theory, Markov chain Monte Carlo, Bayes factor, empirical Bayes, Bayesian linear regression and generalized linear models, hierarchical models.

**Prereq.:** STAT 3717 or STAT 3743 or STAT 4817 or STAT 6940 or equivalent.

**STAT 5840 Statistical Computing 3 s.h.**

Computational methods used in statistics. Topics include generation and testing of random numbers, computer intensive methods, and simulation studies.

**Prereq.:** STAT 3717 or STAT 3743.

**STAT 5846 Categorical Data Analysis 3 s.h.**

Discrete distributions, contingency table analysis, odds ratios, relative risk, logistic regression, hierarchical models.

**Prereq.:** STAT 3743 or equivalent.

**STAT 5849 Multivariate Statistical Analysis 3 s.h.**

The statistical analysis of multivariate observations. Topics include multivariate probability distribution theory, regression, analysis of variance, and techniques in data analysis.

**Prereq.:** MATH 3720 and STAT 3743 or equivalent.

**STAT 5857 Statistical Consulting 3 s.h.**

The objective of this course is to cultivate the skills necessary to competently engage in statistical consulting. Topics include problem solving, study design, power and sample size, data management, selection and application of statistical methods, ethical practice, and effective visual and literal communication of results.

**Prereq.:** STAT 4817 or equivalent.

**STAT 5895 Special Topics in Statistics 2-3 s.h.**

The study of a standard statistical topic in depth or the development of a special area of statistics. May be repeated twice.

**Prereq.:** STAT 3717 or STAT 3743.

## Placement and Pathways

**The following documents are provided to clarify mathematics placement and when a placement exam is required.**

### Math Placement Guidelines

Math\_Placement\_Guidelines-Summer\_2022\_ADA.pdf ([http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Math\\_Placement\\_Guidelines-Summer\\_2022\\_ADA.pdf](http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Math_Placement_Guidelines-Summer_2022_ADA.pdf))

### Placement Guides with Paths

Placement\_Guides\_with\_Paths-Summer\_2022\_ADA.pdf ([http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Placement\\_Guides\\_with\\_Paths-Summer\\_2022\\_ADA.pdf](http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Placement_Guides_with_Paths-Summer_2022_ADA.pdf))

### Decision Tool for Math Registration

Decision\_Tool\_for\_Math\_Registration-Summer\_2022\_ADA.pdf ([http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Decision\\_Tool\\_for\\_Math\\_Registration-Summer\\_2022\\_ADA.pdf](http://catalog.yosu.edu/undergraduate/colleges-programs/college-science-technology-engineering-mathematics/department-mathematics-statistics/Decision_Tool_for_Math_Registration-Summer_2022_ADA.pdf))