

# DEPARTMENT OF MATHEMATICS

*College of the Sciences and Mathematics*

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Department of Mathematics (<http://www.wcupa.edu/mathematics/>)  
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The Department of Mathematics offers two different undergraduate programs: a Bachelor of Arts in Mathematics and a Bachelor of Science in Mathematics. Both programs require the same five core mathematics courses, and they share many upper-division courses, which gives students a great deal of flexibility in selecting their ultimate course of study.

- The **B.A. in Mathematics** is designed to prepare students for graduate study in mathematics. The B.A. degree has a language requirement (French, German, or Russian are recommended), which makes it particularly appropriate for students who want to enroll in doctoral programs that require a language.
- The **B.S. in Mathematics** provides students with five different career-oriented programs (concentrations) that prepare graduates for careers in the private and public sectors, namely:
  - **Actuarial Science Program**
  - **Applied and Computational Mathematics Program**
  - **Mathematical Finance Program**
  - **Pure Mathematics Program**
  - **Statistics Program**

The Undergraduate Handbook for Mathematics Majors should be consulted for current degree program requirements.

## Programs

### Majors

- B.A. in Mathematics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-ba/>)
  - Accelerated B.A. in Mathematics to M.A. in Mathematics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-ba/>)
- B.S. in Mathematics - Actuarial Science Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-actuarial-science-concentration/>)
- B.S. in Mathematics - Applied and Computational Mathematics Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-applied-computational-mathematics-concentration/>)
  - Accelerated B.S. in Mathematics - Applied and Computational Mathematics Concentration to M.S. in Applied and Computational Mathematics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-applied-computational-mathematics-concentration/>)
- B.S. in Mathematics - Computational Mathematics Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-computational-mathematics-concentration/>) (**no longer accepting new students**)
- B.S. in Mathematics - Mathematical Finance Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-mathematical-finance-concentration/>)
- B.S. in Mathematics - Mathematics Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-mathematics-concentration/>)

- Accelerated B.S. in Mathematics - Mathematics Concentration to M.A. in Mathematics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-mathematics-concentration/>)
- B.S. in Mathematics - Statistics Concentration (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-statistics-concentration/>)
  - Accelerated B.S. in Mathematics - Statistics Concentration to M.S. in Applied Statistics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-bs-statistics-concentration/>)

### Minors

- Applied Statistics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/applied-statistics-minor/>)
- Computational Science (IMCS) (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/computational-science-interdisciplinary-minor/>)
- Mathematics (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/mathematics-minor/>)
- Mathematics: Grades PK-8 (<http://catalog.wcupa.edu/undergraduate/sciences-mathematics/mathematics/pk-8-grades-mathematics-minor/>)

### Graduate Opportunities

See the graduate catalog for more information on the Mathematics programs. (<http://catalog.wcupa.edu/graduate/sciences-mathematics/mathematics/>)

### Policies

- See undergraduate admissions information. (<http://catalog.wcupa.edu/general-information/admissions-enrollment/undergraduate-admissions/>)
- See academic policies. (<http://catalog.wcupa.edu/undergraduate/academic-policies-procedures/>)

All undergraduate students are held to the academic policies and procedures outlined in the undergraduate catalog. Students are encouraged to review departmental handbooks for program tips, suggested course sequences, and explanations of procedures. When applicable, additional policies for specific department programs may be listed below.

### Advanced Placement Policy

Visit the Registrar's website (<https://www.wcupa.edu/registrar/testCredit.aspx>) for information on how course credit for success on AP exams in mathematics is awarded.

### Accelerated Program Policy

Refer to the Accelerated Programs page (<http://catalog.wcupa.edu/undergraduate/accelerated-programs/>) for more information.

### Admission Requirements for the Accelerated B.S. in Mathematics - Statistics Concentration to the M.S. in Applied Statistics

Students may conditionally enroll in the Accelerated Program at any point during their undergraduate career. If they are current West Chester students, or transfer students, they must have a minimum cumulative GPA of 3.0 in all MAT and STA courses for admission. While enrolled within the Accelerated Program, students must maintain this minimum cumulative GPA of 3.0 in their MAT and STA courses throughout their undergraduate career.

## Faculty

### Professors

Brian Bowen (bbowen@wcupa.edu) (2010)  
B.S.Ed., West Chester University; M.Ed., Ph.D., University of Delaware

Michael J. Fisher (mfisher@wcupa.edu) (2008)  
B.S., Millersville University; M.S., Ph.D., Lehigh University

Gail M. Gallitano (ggallitano@wcupa.edu) (1992)  
Graduate Coordinator, Mathematics  
B.S., Monmouth University; M.S., Farleigh Dickinson University; M.A., M.Ed., Ed.D., Columbia University

Robert J. Gallop (rgallop@wcupa.edu) (2001)  
B.S., Pennsylvania State University; M.S., Ph.D., Drexel University

Peter L. Glidden (pglidden@wcupa.edu) (1995)  
Chairperson, Mathematics  
B.A., College of Wooster; M.A., Ph.D., Columbia University

Clifford A. Johnston (cjohnston@wcupa.edu) (1992)  
B.S.E., Mansfield University; M.A., Ph.D., Temple University

Allison Kolpas (akolpas@wcupa.edu) (2011)  
Graduate Coordinator, Mathematics  
Assistant Chairperson, Mathematics  
B.A., Revelle College; M.A., Ph.D., University of California, Santa Barbara

Scott McClintock (smcclintock@wcupa.edu) (2007)  
B.S., San Jose State University; M.S., M.A., Ph.D., University of Kentucky

Mark A. McKibben (mmckibben@wcupa.edu) (2013)  
B.S., M.S., Ph.D., Ohio University

James McLaughlin (jmclaughlin@wcupa.edu) (2005)  
B.S., University of Ulster; M.S., Queen's University Belfast; Ph.D., University of Illinois

Scott Parsell (sparsell@wcupa.edu) (2009)  
B.S., Massachusetts Institute of Technology; M.S., Ph.D., University of Michigan

Randall H. Rieger (rrieger@wcupa.edu) (2000)  
B.A., Bowdoin College; M.S., Ph.D., University of North Carolina

Lin Tan (ltan@wcupa.edu) (1989)  
B.S., M.A., Zhejiang University; M.S., Ph.D., University of California, Los Angeles

### Associate Professors

Jeremy Brazas (jbrazas@wcupa.edu) (2017)  
B.S., M.S.Ed., Harding University; Ph.D., University of New Hampshire

Andrew Crossett (acrossett@wcupa.edu) (2012)  
B.A., Canisius College; M.A., Ph.D., Carnegie Mellon University

Shiv K. Gupta (sgupta@wcupa.edu) (1985)  
B.S., M.S., Delhi University; M.S., University of Wisconsin; Ph.D., Case Western Reserve University

Kim Johnson (kjohnson2@wcupa.edu) (2013)  
B.S., MS.Ed., Millersville University; Ph.D., Pennsylvania State University

Chuan Li (cli@wcupa.edu) (2016)  
B.S., University of Science and Technology of China; M.S., Ohio University; Ph.D., University of Tennessee Knoxville

Emily K. Miller (emiller@wcupa.edu) (2016)  
B.A., The College of New Jersey; M.S., Ph.D., University of Delaware

Cheng Peng (cpeng@wcupa.edu) (2019)  
B.A., East China Normal University; M.A., Ph.D., University of Toledo

### Assistant Professors

Premalatha Junius (pjuniu@wcupa.edu) (2014)  
B.S., M.S., University of Madras; M.A., Ph.D., University of Northern Colorado

Laura Pyott (lpyott@wcupa.edu) (2017)  
B.S., University of Richmond; M.S., University of Delaware

Rosemary Sullivan (rsullivan@wcupa.edu) (2008)  
B.S., Pennsylvania State University; M.S., Ph.D., Lehigh University

Barbara Swartz (bswartz@wcupa.edu) (2020)  
B.A., M.A., Lehigh University; Ph.D., University of Virginia

Peter Zimmer (pzimmer@wcupa.edu) (2000)  
B.S., M.S., University of Wisconsin; Ph.D., University of Kansas

## Courses

### MAT

#### MAT Q20. Fundamental Skills in Arithmetic. 3 Credits.

This course is designed to strengthen basic arithmetic skills and to introduce the elements of algebra. Mathematics placement required. Credits earned in Q00-level courses do not count toward the 120 hours of credit needed for graduation.

Pre / Co requisites: MAT Q20 requires a prerequisite of an appropriate score on the Mathematics Placement Examination.

Distance education offering may be available.

Typically offered in Fall, Spring, Summer, Winter.

#### MAT Q30. Fundamentals of Algebra. 3 Credits.

This course is designed to strengthen basic algebraic skills. Credits earned in Q00-level courses do not count toward the 120 hours of credit needed for graduation.

Pre / Co requisites: MAT Q30 requires an appropriate score on the Mathematics Placement Examination.

Distance education offering may be available.

Typically offered in Fall, Spring, Summer, Winter.

#### MAT 101. Mathematics for Teachers of Children I. 3 Credits.

Sets; functions; logic; development of whole numbers, integers, and rationals (including ratios, proportions, and percents); number theory; problem solving. For students seeking Certification in Grades PK-4 or 4-8 only.

Pre / Co requisites: MAT 101 requires a grade of C- or better in MAT Q20 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring & Summer.

#### MAT 102. Mathematics for Teachers of Children II. 3 Credits.

Development of real numbers; geometry; measurement; probability and statistics; problem solving. For students seeking Certification in Grades PK-4 or 4-8 only.

Pre / Co requisites: MAT 102 requires prerequisite of MAT 101.

Typically offered in Fall, Spring & Summer.

#### MAT 103. Introduction to Mathematics. 3 Credits.

This course is a liberal arts introduction to the nature of mathematics. Topics are chosen from among logic, graph theory, number theory, symmetry (group theory), probability, statistics, infinite sets, geometry, game theory, and linear programming. These topics are independent of each other and have as prerequisite the ability to read, reason, and follow a logical argument.

Pre / Co requisites: MAT 103 requires a prerequisite of a grade of C- or better in MAT Q20 or an appropriate score on the Mathematics Placement Examination.

Distance education offering may be available.

Typically offered in Fall, Spring, Summer, Winter.

**MAT 104. Introduction to Applied Mathematics. 3 Credits.**

The course is designed to help prepare students to understand almost any quantitative issues they will encounter in contemporary society. Topics are selected from the following: principles of reasoning, problem-solving tools, financial management, exponential growth and decay, probability, putting statistics to work, mathematics and the arts, discrete mathematics in business and society and the power of numbers.

Pre / Co requisites: MAT 104 requires a prerequisite of a grade of C- or better in MAT Q20 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring & Summer.

**MAT 113. Algebra and Functions. 3 Credits.**

A review of basic algebra, followed by a thorough treatment of polynomial, rational, exponential, and logarithmic functions. Successful completion of this course prepares students for MAT 143.

Pre / Co requisites: MAT 113 requires a prerequisite of a grade of C- or better in MAT Q30 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring, Summer, Winter.

**MAT 115. Algebra, Functions, and Trigonometry. 3 Credits.**

Topics include polynomial, rational, exponential, logarithmic, and trigonometric functions.

An emphasis is placed on using technology to understand topics of importance in the life and earth sciences. Successful completion of this course prepares students for MAT 143 or MAT 145. Pre / Co requisites: MAT 115 requires a grade of C- or better in MAT Q30 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall & Spring.

**MAT 121. Introduction to Statistics I. 3 Credits.**

Introduction to statistics and statistical inference. Concepts include: descriptive statistics, sampling distributions, confidence intervals, hypothesis testing, along with a formal introduction to linear regression and categorical data analysis. Statistical software including, but not limited to SPSS and Excel, will be used to facilitate the understanding of important statistical ideas and for the implementation of data analysis in many areas of application.

Pre / Co requisites: MAT 121 requires a prerequisite of a grade of C- or better in MAT Q20 or an appropriate score on the Mathematics Placement Examination.

Distance education offering may be available.

Typically offered in Fall, Spring, Summer, Winter.

**MAT 125. Introduction to Statistics and Probability. 3 Credits.**

Introduction to probability, statistics, and statistical inference. Concepts include: descriptive statistics, probability, probability distributions, sampling distributions, confidence intervals, hypothesis testing, along with a formal introduction to linear regression and categorical data analysis. Statistical software, including but not limited to SPSS and Excel, will be used to facilitate the understanding of important statistical ideas and for the implementation of data analysis in many areas of application.

Pre / Co requisites: MAT 125 requires an appropriate score on the Mathematics Placement Exam.

Typically offered in Fall & Spring.

**MAT 131. Precalculus. 3 Credits.**

Topics include polynomial, rational, exponential, logarithmic, and trigonometric functions.

An emphasis is placed on understanding function properties and graphs without the use of technology. Successful completion of this course prepares students for MAT 161.

Pre / Co requisites: MAT 131 requires a prerequisite of a grade of C- or better in MAT Q30 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring & Summer.

**MAT 143. Brief Calculus. 3 Credits.**

An intuitive approach to calculus with emphasis on conceptual understanding and applications to business. Topics include differentiation, curve-sketching, optimization, integration, and partial derivatives.

Pre / Co requisites: MAT 143 requires a prerequisite of a grade of C- or better in MAT 113, MAT 115, or MAT 131; or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring, Summer, Winter.

**MAT 145. Calculus for the Life Sciences. 3 Credits.**

An overview of differential and integral calculus, motivated through biological problems.

Topics include mathematical modeling with functions, limits, continuity, differentiation, optimization, and integration. Graphing calculators are used as an aid in the application of calculus concepts and methods to realistic biological problems.

Pre / Co requisites: MAT 145 requires a prerequisite of a grade of C or better in MAT 115 or MAT 131; or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall & Spring.

**MAT 151. Introduction to Discrete Mathematics. 3 Credits.**

Set theory, Boolean logic, elementary combinatorics, proofs, simple graph theory, and simple probability.

Pre / Co requisites: MAT 151 requires a prerequisite of a grade of C- or better in MAT Q30 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring & Summer.

**MAT 161. Calculus I. 4 Credits.**

Differential and integral calculus of real-valued functions of a single real variable with applications.

Pre / Co requisites: MAT 161 requires prerequisites of a C or better in MAT 131 or an appropriate score on the Mathematics Placement Examination.

Typically offered in Fall, Spring & Summer.

**MAT 162. Calculus II. 4 Credits.**

Continuation of MAT 161 including the study of series, methods of integration, transcendental functions, and applications to the sciences.

Pre / Co requisites: MAT 162 requires prerequisite of C or better in MAT 161.

Typically offered in Fall, Spring & Summer.

**MAT 190. Topics in Mathematics. 3 Credits.**

Topics announced at time of offering.

Consent: Permission of the Department required to add.

**MAT 200. The Nature of Mathematics. 3 Credits.**

Topics include the role of mathematics in contemporary society, career opportunities, mathematical notation and argument, structure of proofs, basic facts about logic, mathematical proofs, problem-solving techniques, and introductions to mathematical software packages.

Pre / Co requisites: MAT 200 requires a prerequisite of C or better in MAT 161. Course should be taken by the end of sophomore year.

Typically offered in Fall & Spring.

**MAT 243. Calculus and Linear Algebra for Applied Statistics. 4 Credits.**

This course is designed to survey concepts from calculus and linear algebra that are relevant to the study of applied statistics. Topics include a review of differentiation and the Fundamental Theorem of Calculus, techniques and applications of integration, infinite series, partial derivatives, multiple integrals, matrix operations, linear transformations, and eigenvectors.

Pre / Co requisites: MAT 243 requires a prerequisite of a C or higher in MAT 143 or MAT 161 or equivalent.

Distance education offering may be available.

Typically offered in Spring & Summer.

**MAT 261. Calculus III. 4 Credits.**

The calculus of several variables. Topics include polar coordinates, vectors and three-dimensional analytic geometry, differentiation of functions of several variables, multiple integrals, and line and surface integrals.

Pre / Co requisites: MAT 261 requires a prerequisite of MAT 162 with a C or better.

Typically offered in Fall, Spring & Summer.

**MAT 301. The Scientific Revolution. 3 Credits.**

This course addresses how modern science began in the 17th century by examining its origins and including introductions to the heroes of science - Copernicus, Kepler, Galileo, and Newton.

Gen Ed Attribute: Interdisciplinary Requirement, Writing Emphasis.

Typically offered in Spring.

**MAT 302. Mathematics and Social Justice. 3 Credits.**

In this course we will explore several social issues and we will discuss methods which can quantitatively illustrate that are taking place. By doing so, the hope is that each student will learn mathematical skills and techniques. This tool kit of basic mathematical skills is often referred to as Quantitative Literacy (QL). Moreover as attainment of QL is itself a social justice issue, we will explore ways to carry these skills to historically marginalized groups through service learning projects.

**MAT 311. Linear Algebra. 3 Credits.**

An introduction to linear algebra. Topics covered include matrices, systems of linear equations, vector spaces, linear transformation, determinants, eigenvalues, spectral theorem, and triangulation.

Pre / Co requisites: MAT 311 requires Concurrent or Prerequisite of MAT 162.

Typically offered in Fall, Spring & Summer.



**MAT 312. Algebra for Teachers in Grades 4-8. 3 Credits.**

Formal structure of groups, rings, and fields with examples from the elementary curriculum. Topics from linear algebra including matrices, determinants, and linear programming. Pre / Co requisites: MAT 312 requires prerequisite of MAT 102. Typically offered in Spring.

**MAT 313. Geometry for Teachers in Grades 4-8. 3 Credits.**

Modern informal approach to two- and three-dimensional geometric figures, measurement, similarity, congruence, coordinate geometry, and the postulational method. Pre / Co requisites: MAT 313 requires prerequisite of MAT 102. Typically offered in Fall.

**MAT 315. Differential Equations and Linear Algebra. 3 Credits.**

An introduction to linear algebra and differential equations. Topics include matrices, vector spaces, linear dependence, determinant, eigenvalues and eigenvectors, ordinary differential equations, initial value problems, and systems of linear ordinary differential equations. Applications to physics and engineering will be emphasized. Pre / Co requisites: MAT 315 requires a prerequisite of C or better in MAT 162. Typically offered in Spring.

**MAT 321. Combinatorics and Graph Theory. 3 Credits.**

Introduction to set theory, graph theory, and combinatorial analysis. Includes relations, cardinality, elementary combinatorics, principles of inclusion and exclusion, recurrence relations, zero-one matrices, partitions, and Polya's Theorem. Pre / Co requisites: MAT 321 requires prerequisites of C or better in MAT 162 and MAT 200. Typically offered in Fall.

**MAT 325. Numerical Analysis I. 3 Credits.**

A basic introduction to numerical analysis and scientific computing. Topics which will be studied include: Computer arithmetic, approximation and interpolation of functions, numerical quadratures, solutions of linear systems by direct methods, numerical solutions of nonlinear scalar equations, numerical differentiation, introduction to one step methods for the numerical solution of ordinary differential equations. Pre / Co requisites: MAT 325 requires a prerequisite of MAT 162 with a "C" or better. Typically offered in Spring.

**MAT 331. Foundations of Geometry. 3 Credits.**

Geometric foundations from an advanced viewpoint. Topics are chosen from euclidean and noneuclidean geometrics. Pre / Co requisites: MAT 331 requires prerequisite of C or better in MAT 162. Typically offered in Spring.

**MAT 332. Differential Geometry. 3 Credits.**

Classical differential geometry from a modern viewpoint. Curves and surfaces and shape operators. Introduction to Riemann geometry. Pre / Co requisites: MAT 332 requires a prerequisite of C or better in MAT 200, MAT 261, and MAT 331. Typically offered in Fall.

**MAT 343. Differential Equations. 3 Credits.**

The general theory of nth order, and linear differential equations including existence and uniqueness criteria and linearity of the solution space. General solution techniques for variable coefficient equations, series solutions for variable coefficient equations, and study of systems of linear equations. Pre / Co requisites: MAT 343 requires a prerequisite of C or better in MAT 162 and MAT 311. Typically offered in Spring.

**MAT 351. Methods for Teaching Children Math. 3 Credits.**

In-depth treatment of current pedagogical strategies and materials for teaching concepts, including: early number sense; place value; addition, subtraction, multiplication, and division of whole numbers; and fractions in an elementary classroom. Pre / Co requisites: MAT 351 requires prerequisites of MAT 101 and MAT 102. Typically offered in Fall, Spring & Summer.

**MAT 352. Methods for Teaching Children Mathematics II. 3 Credits.**

A continuation of the pedagogical strategies and methods for teaching the topics covered in MAT 351 extended to topics such as real numbers, geometry, percent, proportional reasoning, measurement, and algebra. Pre / Co requisites: MAT 352 requires prerequisites of MAT 351, field clearances, and Teacher Candidacy. Typically offered in Fall & Summer.

**MAT 353. Methods for Teaching Middle School Mathematics. 3 Credits.**

Techniques for teaching children mathematical concepts in the middle school standards. Topics covered include number, algebra, geometry, and probability and statistics. Pre / Co requisites: MAT 353 requires prerequisites of MAT 121, MAT 351, field clearances, and Teacher Candidacy, as well as corequisites of MAT 312 and MAT 313. Typically offered in Fall & Summer.

**MAT 371. Mathematics of Finance. 3 Credits.**

The purpose of this course is to introduce the mathematical theory behind the concepts of: measurement of interest, annuities, yield rates, amortization of loans, sinking funds, and yield rates. Understanding the fundamental concepts of financial mathematics, and how these concepts can be applied to calculate present and future values of various financial instruments, is the prevailing theme of the course. Pre / Co requisites: MAT 371 requires a prerequisite of C or better in MAT 162. Typically offered in Fall.

**MAT 390. Seminar in Mathematics Education. 3 Credits.**

This course is the capstone course for grades 4-8 certification students completing the 30-credit mathematics certification option. Topics selected from mathematics, statistics, the history of mathematics, and mathematics education for their significance and interest. Field experience may be required. Pre / Co requisites: MAT 390 requires a prerequisite of Teacher Candidacy. Typically offered in Fall. Repeatable for Credit.

**MAT 400. History of Mathematics for Elementary Teachers. 3 Credits.**

History and development of elementary mathematics from primitive times to the discovery of calculus. Problems of the period are considered. Pre / Co requisites: MAT 400 requires prerequisites of MAT 312 and MAT 313.

**MAT 401. History of Mathematics. 3 Credits.**

This course will cover selected topics from the history of mathematics. Many great mathematicians will be studied including Hippocrates, Euclid, Archimedes, Heron, Cardano, Newton, the Bernoulli Brothers, Euler, Gauss, and others. Mathematics problems will be approached using the methods and knowledge of the era studied. A solid background in undergraduate mathematics is required. Pre / Co requisites: MAT 401 requires a prerequisite of a C or better in MAT 261. Gen Ed Attribute: Speaking Emphasis, Writing Emphasis. Typically offered in Spring.

**MAT 405. Special Topics in Mathematics. 3 Credits.**

Topics announced at the time of offering. Consent: Permission of the Department required to add. Repeatable for Credit.

**MAT 411. Algebra I. 3 Credits.**

Abstract algebra. Algebraic systems, groups, rings, integral domains, and fields. Pre / Co requisites: MAT 411 requires prerequisites of C or better MAT 200, MAT 261, and MAT 311. Typically offered in Fall & Spring.

**MAT 412. Algebra II. 3 Credits.**

Abstract algebra. Algebraic systems, groups, rings, integral domains, and fields. Pre / Co requisites: MAT 412 requires prerequisite of C or better in MAT 411. Typically offered in Spring.

**MAT 413. Computer Algebra. 3 Credits.**

The focus of this course is to introduce students to computer algebra packages and review important topics in algebra, calculus and linear algebra. Pre / Co requisites: MAT 413 requires prerequisites of MAT 162 and MAT 311 with a "C" or better. Typically offered in Fall.

**MAT 414. Theory of Numbers. 3 Credits.**

Properties of integers; primes, factorization, congruences, and quadratic reciprocity. Pre / Co requisites: MAT 414 requires prerequisites of C or better in MAT 200 and MAT 261. Typically offered in Spring.

**MAT 415. Introduction to Cryptography. 3 Credits.**

An introduction to the mathematics behind various aspects of modern cryptography, including matrix cryptosystems, quadratic ciphers such as the Rabin cipher, exponential ciphers such as the Diffie-Hellman Key Exchange, the RSA algorithm and DES encryption.

Pre / Co requisites: MAT 415 requires prerequisites of MAT 161 and MAT 151 OR MAT 161 and MAT 200.

Typically offered in Spring.

**MAT 421. Mathematical Statistics I. 3 Credits.**

Probability; discrete distributions; continuous distributions; mathematical expectation; moment generating functions; bivariate distributions; distributions of functions of random variables. Use of appropriate technology.

Pre / Co requisites: MAT 421 requires a prerequisite of C or better in MAT 261 or a corequisite of MAT 261.

Typically offered in Fall & Spring.

**MAT 422. Mathematical Statistics II. 3 Credits.**

Order statistics; point estimation; interval estimation; tests of statistical hypotheses; statistics power; least squares regression. Use of appropriate technology.

Pre / Co requisites: MAT 422 requires prerequisite of C or better in MAT 421 and either MAT 121 or MAT 125.

Typically offered in Spring.

**MAT 423. Applied Probability. 3 Credits.**

Standard Concepts and methods of stochastic modeling and applications of stochastic processes.

Pre / Co requisites: MAT 423 requires prerequisites of MAT 261, MAT 311, and MAT 421 with a "C" or better.

Typically offered in Spring.

**MAT 425. Numerical Analysis II. 3 Credits.**

An examination of advanced topics in numerical analysis and scientific computing. Topics include: Approximation and interpolation of functions, numerical quadratures, matrix norms, iterative methods of numerical linear algebra, numerical solution of nonlinear systems of equations, and methods for the numerical solution of ordinary differential equations.

Pre / Co requisites: MAT 425 requires a prerequisite of C or better in MAT 325.

Typically offered in Fall.

**MAT 427. Introduction to Optimization Techniques. 3 Credits.**

Nature of optimization problems: deterministic and stochastic, and discrete and continuous. Computer methods of solution, systematic and random search, linear quadratic, dynamic programming, and others.

Pre / Co requisites: MAT 427 requires prerequisites of C or better in MAT 261 and C or better in MAT 311.

Typically offered in Fall.

**MAT 432. Topology. 3 Credits.**

Elements of point set topology. Separation axioms. Connectedness, compactness, and metrizable.

Pre / Co requisites: MAT 432 requires prerequisites of C or better in MAT 200 and MAT 261.

Typically offered in Spring.

**MAT 441. Real Analysis I. 3 Credits.**

Introduces the real line, limits of sequences, Cauchy sequences, limits of real functions, continuous functions, intermediate value theorem, the derivative, mean value theorems and Riemann integral.

Pre / Co requisites: MAT 441 requires prerequisites of C or better in MAT 200 and MAT 261.

Typically offered in Fall & Spring.

**MAT 442. Real Analysis II. 3 Credits.**

A continuation of MAT 441. Introduces infinite series, sequences and series of functions, Taylor's Theorem with applications and topics from integration theory.

Pre / Co requisites: MAT 442 requires prerequisite of C or better in MAT 441.

Typically offered in Fall.

**MAT 443. Applied Analysis I. 3 Credits.**

The techniques of analysis applied to problems in the physical sciences. Topics include partial differential equations, orthogonal functions, complex integration, and conformal mapping.

Pre / Co requisites: MAT 443 requires prerequisite of C or better MAT 261, MAT 311 and MAT 343.

Typically offered in Spring.

**MAT 444. Applied Analysis II. 3 Credits.**

The techniques of analysis applied to problems in the physical sciences. Topics include partial differential equations, orthogonal functions, complex integration, and conformal mapping.

Pre / Co requisites: MAT 444 requires prerequisite of C or better in MAT 443.

**MAT 445. Complex Variables. 3 Credits.**

Introduction to functions of a complex variable. Analytic functions, mappings, differentiation and integration, power series, and conformal mappings.

Pre / Co requisites: MAT 445 requires prerequisite of C or better in MAT 261.

Typically offered in Fall.

**MAT 455. Industrial Mathematics Practicum. 3 Credits.**

This is a case study, team problem-solving based course focused on solving real-world problems that can be modeled using discrete or continuous mathematics techniques and which emanate from industry. Ideally, the problems would be obtained from partnerships with local industry. Until these relationships develop, extant problems or problems arising in WCU faculty research (in math, physics, biology, geology, finance, etc.) will be used.

Pre / Co requisites: MAT 455 requires prerequisites of STA 319, MAT 425, and MAT 413 and any one of MAT 493 or MAT 427.

Typically offered in Spring.

Repeatable for Credit.

**MAT 478. Fundamentals of Actuarial Science. 3 Credits.**

Students completing this course will have a better understanding of actuarial models of life contingencies, more specifically, students will understand that life insurance payments, life annuity payments, pension payments, etc. are determined by financial random variables dependent on human life.

Pre / Co requisites: MAT 478 requires prerequisite of MAT 371 and MAT 421 with a "C" or better.

Typically offered in Spring.

**MAT 479. Financial Calculus. 3 Credits.**

This course aims to provide the undergraduate mathematics major with an introduction to the mathematics behind derivative pricing and portfolio management. Pricing theory is first developed through the typical binomial model and then is extended to continuous time via the Black-Scholes model. In addition, the student will be exposed to how arbitrage can be used to aid in the pricing more complicated derivatives, such as call options on dividend-paying securities and exotic options.

Pre / Co requisites: MAT 479 requires prerequisite of MAT 371 and MAT 421 with a "C" or better.

Typically offered in Spring.

**MAT 491. Internship in Applied Mathematics. 2-4 Credits.**

In cooperation with regional businesses and industrial companies, student will perform an internship in applied mathematics.

Repeatable for Credit.

**MAT 493. Mathematical Modeling. 3 Credits.**

The idea of a mathematical model of a real situation. Techniques and rationales of model building. Examples from the life, physical, and social sciences.

Pre / Co requisites: MAT 493 requires prerequisites of C or better in MAT 261 and C or better in MAT 343.

Typically offered in Fall.

**MAT 499. Independent Study in Mathematics. 1-3 Credits.**

Independent investigation of an area of mathematics not covered in the department's course offerings.

Consent: Permission of the Department required to add.

Repeatable for Credit.

**MTE****MTE 340. Using Technology Teaching Elementary Mathematics. 3 Credits.**

Using computer software, calculators, and the Internet as aids in teaching elementary school mathematics.

Pre / Co requisites: MTE 340 requires prerequisites of MAT 101 and MAT 102.

**STA****STA 200. Introduction to Statistics II. 3 Credits.**

Continuation of MAT 121/MAT 125. Topics include inference about the means, standard deviations and proportions, goodness of fit, analysis of variance, regression analysis, correlation, and nonparametric tests. In addition, students will learn to use SPSS, a statistical analysis software that is available for free through the Ram Cloud. Finally, students will hone their technical writing skills by summarizing their statistical analyses with written reports.

Pre / Co requisites: STA 200 requires a prerequisite of a grade of C- or better in MAT 121, MAT 125 or ECO 251.

Distance education offering may be available.

Typically offered in Fall & Spring.

**STA 201. Statistical Methods for Political Polling. 3 Credits.**

The purpose of this course is to introduce students to the statistical methodology used in the analysis of data from a political survey. Topics will include sampling techniques, hypothesis testing, sample size calculation, categorical data analysis, simple linear regression, and ANOVA. There will be a field trip to the Center for Opinion Research at Franklin and Marshall College at the beginning of the semester.

Pre / Co requisites: STA 201 requires a prerequisite of MAT 121 or PSC 200.

Typically offered in Fall.

**STA 202. Sports Analytics. 3 Credits.**

In this course we will apply concepts such as regression, classification, clustering, decision trees and others to evaluate players and teams from baseball, basketball, football, hockey and soccer. We will also introduce the statistical programming language R in order to analyze recent (and large!) data sets.

Pre / Co requisites: STA 202 requires a prerequisite of a C- or higher in MAT 121 and MAT 125, or ECO 251.

Typically offered in Fall.

**STA 203. Probability and Statistics in Gaming. 3 Credits.**

In this class students will learn the important role that probability and statistics play in the enjoyment and development of games ranging from blackjack and the lottery to Battleship and World of Warcraft. Statistical topics include descriptive statistics, probability, discrete random variables, and multivariate linear modeling. Throughout the course students will use statistical tools to not only develop optimal strategies while gaming but also to analyze the current trends in contemporary gaming, determine which factors correlate with a game's popularity, and how to develop algorithms for computer opponents.

Pre / Co requisites: STA 203 requires a prerequisite of MAT 121 or MAT 125.

Typically offered in Spring.

**STA 311. Intro Statistical Computing and Data Management. 3 Credits.**

Course will give students the ability to manage and manipulate data effectively, conduct basic statistical analysis, and generate reports and graphics primarily using the SAS Statistical Software Program.

Pre / Co requisites: STA 311 requires a prerequisite of MAT 121 or MAT 125.

Distance education offering may be available.

Typically offered in Spring.

**STA 319. Applied Statistics. 3 Credits.**

This course will cover simple and multiple linear regression methods and linear time series analysis with an emphasis on fitting suitable models to data and testing and evaluating models against data.

Pre / Co requisites: STA 319 requires a prerequisite of C or better in (MAT 121 or MAT 125) and (MAT 143 or MAT 145 or MAT 161).

Typically offered in Fall & Spring.

**STA 320. Experimental Design. 3 Credits.**

The purpose of this course is to guide students in learning how to design, conduct and analyze the results of scientific studies so that valid and objective inferences about the population are obtained. It will cover ANOVAs, block, factorial, and split plot designs, as well as response surface analysis.

Pre / Co requisites: STA 320 requires a prerequisite of C or better in MAT 121 or MAT 125.

Typically offered in Fall.

**STA 321. Topics in Advanced Statistics. 3 Credits.**

Course will cover select topics in categorical analysis, nonparametrics and time series analysis. Emphasis will be placed on statistical programming, particularly simulations.

Pre / Co requisites: STA 321 requires prerequisites of C or better in STA 311, STA 319, STA 320, and MAT 421.

Typically offered in Spring.

**STA 419. Basics of Statistical Learning. 3 Credits.**

This course will provide an introduction to statistical learning and predictive modeling. Tools will be developed for visualizing and understanding complex data sets. All data analysis will be done using the statistical programming language R.

Pre / Co requisites: STA 419 requires a prerequisite of a C or better in STA 319.

Distance education offering may be available.

Typically offered in Fall.

**STA 490. Capstone Course in Statistics. 3 Credits.**

Course will synthesize lessons learned throughout the students career with the goal of preparing students for work as professional statisticians. Topics will include report writing, presentations, statistical consulting, sampling design, and resume writing.

Pre / Co requisites: STA 490 requires prerequisites of ENG 368 or ENG 375 or ENG 371 and a C or better in STA 320 and STA 321.

Typically offered in Fall.