

# Department of Mathematics

**FACULTY** Professors Jungck, McAsey (chair), Szeto, Timm; Associate Professors Bedenikovic, Delgado, Hahn, Kasube, Mou, Nanyes, Quigg, Xue; Assistant Professors Haverhals, Lang; Lecturer Sterling.

A student considering mathematics as a career should realize that emphasis in mathematics courses will change as the individual progresses through an academic program. The initial concern for solving problems is later dominated by the more important objectives of formulating problems in mathematical language and dealing with mathematical structures and abstract ideas. It should be stressed that an effective mathematician should be a well-educated person, possessing not only the technical background of mathematics but also a selection of courses from other disciplines.

## Mathematics Major

All students majoring in mathematics must meet the following departmental requirements:

- The mathematics core curriculum  
MTH 121, 122, 223 Calculus I, II, III  
MTH 207 Elementary Linear Algebra with Applications  
MTH 420 Introduction to Analysis  
MTH 325 Probability and Statistics I  
MTH 404 Modern Algebra I  
MTH 494, 495 Senior Project I, II  
CS 106 Programming
- At least two of the following sequences:  
MTH 420 and 421 or 403; MTH 325 and 326; MTH 404 and 405; MTH 501 and 502; MTH 510 and 511.  
Other sequences may be approved by the department; however, any two sequences must include four distinct courses.
- At least 24 semester hours of mathematics courses numbered 301 or above. Upper level core and sequence courses are counted as part of this requirement.

Unless the requirements of a course have been met through some other means such as testing or transfer credit, all entering mathematics majors are advised to begin their academic program with the following course of study.

## Freshman Year

MTH 121, 122 Calculus I, II.....	8
CS 106 Programming.....	3
ENG 101 English Composition.....	3
COM 103 Oral Communication Process.....	3
Electives.....	15
	32

The Department of Mathematics recognizes that students majoring in mathematics will have diverse career interests and goals. In fact, flexibility is one of the desirable attributes of a major in mathematics. With proper selection of elective courses, programs may be designed for students who wish to specialize in mathematics, teach at the high school level, or for students with career interests in the application of mathematics to, for example, actuarial science, business, computer science, economics or the physical sciences. By selecting appropriate courses, mathematics majors will often complete a minor in one of these applied areas. Some suggestions are as follows:

## Mathematics

Students considering further study of mathematics at the graduate level should elect courses such as:

- MTH 307 Linear Algebra
- MTH 345 Differential Equations
- MTH 403 Complex Variables
- MTH 405 Modern Algebra II
- MTH 406 Elementary Topology
- MTH 421 Advanced Calculus

In addition, a year of physics (PHY 110 and 201) and a foreign language may prove beneficial.

## Mathematics - Secondary Education

Students wishing to be certified to teach mathematics at the secondary level in Illinois enroll in the Bradley University Mathematics Department MTHHT major program. The mathematics requirements for this degree program consist of a core of required classes, the fulfillment of a breadth requirement, and a depth requirement. In addition, to be certified to teach mathematics at the secondary level in the state of Illinois one must complete the requirements for a secondary teaching certificate. These requirements are listed under the Department of Teacher Education (Secondary Programs) and include a minimum of 35 hours in education courses.

- The mathematics core curriculum for the MTH program is:  
MTH 121 Calculus with Analytic Geometry I  
MTH 122 Calculus with Analytic Geometry II  
MTH 223 Calculus with Analytic Geometry III  
MTH 207 Linear Algebra  
MTH 325 Probability and Statistics I  
MTH 404 Abstract Algebra I  
MTH 420 Real Analysis I  
CS 106 Intro. to Programming & Computer Science
- The depth requirement can be fulfilled by completing two sequences from among the following five sequences: MTH 325-326, MTH 404-405, MTH 420 and MTH 421 or MTH 403, MTH 501-502, MTH 510-511.
- The breadth requirement can be fulfilled by completing a total of 24 semester hours in courses numbered 301 and above. Upper-level mathematics in the core curriculum and sequence course are counted in this total.
- The state currently requires that students be introduced to various topics in order to meet certification requirements. Most of the mathematical topics required for certification are covered in the core curriculum described in number 1 above. Currently, there are additional certification requirements in graph theory, geometry, and history of mathematics. State certification requirements change frequently. It is the student's responsibility to see that the current state certification requirements are satisfied.

### Actuarial Science – Mathematics Major

The actuarial field is one of the oldest applications of mathematics and deals with insurance, annuity, and pension plans of all kinds.

An actuarial science-mathematics major is

- Required to take the following courses:
 

MTH 121, 122, 223 Calculus I, II, III.....	12
MTH 207 Elementary Linear Algebra.....	3
MTH 325, 326 Probability and Statistics I, II.....	6
MTH 335 Topics in Actuarial Science (two different topics) .....	6
MTH 427 Applied Statistical Methods .....	3
Elective mathematics courses (see note 2).....	6
CS 106 Programming.....	3
ATG 157 Accounting Principles I.....	3
ECO 221, 222 Microeconomics, Macroeconomics .....	6
IME 313 Operations Research I.....	3
IME 314 Operations Research II.....	3
RMI 315 Principles of Risk Management .....	3
FIN 322 Business Finance .....	3
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	60

- Required to take at least two additional three-hour courses from courses numbered MTH 301 or above other than MTH 325, MTH 326, MTH 335 and MTH 427.
- For an AS-M major a maximum of 25 percent of the total undergraduate program credit hours including required courses may consist of courses from the Foster College of Business Administration. For example, in a 124-credit-hour program a maximum of 31 credit hours of business courses may be taken.

Although no additional business courses are required, students wishing to take business courses in addition to those required courses listed above should consider choosing from among the following, subject to the restriction noted above: BUS 100, BUS 210, BUS 300, IB 306, ATG 158, MTG 315, BUS 342, BMA 352, BMA 372, BMA 452, ECO 301, FIN 325, FIN 425, any RMI course.

### Mathematics Minor

A mathematics minor requires 24 semester hours in mathematics as follows:

- MTH 121, 122, 223 Calculus I, II, III; and
- 12 semester hours in mathematics courses numbered 301 or above; or either MTH 207 or MTH 224 and 9 semester hours in mathematics courses numbered 301 or above.

### Advanced Placement in Mathematics

Students scoring a 5, 4 or 3 on the Advanced Placement (AP) program mathematics examination administered by the College Entrance Examination Board may receive up to eight semester hours of credit for MTH 121 and MTH 122 Calculus I and II.

### Course Descriptions

**NOTE:** Not more than 10 semester hours of credit may be earned from the following courses: MTH 100, 101, 105, 109, 110, and 111. Credit will not be given for MTH 101, 105, or 109 to students with credit for MTH 112 or 115. Credit will not be given for MTH 101, 105, 109, 110, 112, or 115 to students with credit for MTH 119 or MTH 121. Credit will not be given for both MTH 116 and MTH 122. Students majoring in departments of the colleges of business administration and engineering and technology are advised to check college requirements for additional restrictions and limitations.

#### MTH 100 Intermediate Algebra 2 hrs.

Developmental course emphasizing algebraic manipulations. Intended for students with minimal background in mathematics. Basic operations with real numbers, polynomials, factoring, properties of exponents, solving linear and quadratic equations. Not open to students with credit in any math course numbered above MTH 100.

- MTH 101 Basic College Mathematics** 3 hrs.  
(Gen. Ed. MA)  
Development of basic mathematical skills. Problem solving and contemporary applications. Prerequisite: 3 semesters of high school algebra.
- MTH 105 Finite Mathematics** 3 hrs.  
Topics from finite mathematics: sets, matrices, systems of linear equations, linear programming, elementary probability, multistage processes, and Markov chains. Prerequisite: 3 semesters of high school algebra, or equivalent.
- MTH 109 College Algebra** 3 hrs.  
For students who need to strengthen their algebra skills: factoring polynomials; solving quadratic and other equations; exponents, logarithms, and graphing. Prerequisites: 3 semesters of high school algebra, and qualifying score on algebra placement exam; or grade of C or better in MTH 100.
- MTH 111 Elementary Statistics** 3 hrs.  
(Gen. Ed. MA)  
Probability, descriptive statistics, statistical models, correlation and regression, testing hypotheses, confidence limits, and selected applications. Prerequisite: 3 semesters of high school algebra, or equivalent.
- MTH 112 Precalculus** 4 hrs.  
For students needing further background in mathematics before enrolling in calculus (especially MTH 121). Thorough study of algebraic, transcendental, and trigonometric functions; emphasis on graphing and use of algebra. Prerequisites: 3 years of high school math including 3 semesters of high school algebra; appropriate entrance and/or math precalculus placement scores.
- MTH 115 Brief Calculus with Applications I** 4 hrs.  
(Gen. Ed. MA)  
Differential and integral calculus with emphasis on understanding through graphs. Topics in analytic geometry, limits, derivatives, antiderivatives, definite integrals, exponential and logarithmic functions, and partial derivatives. Prerequisite: grade of C or better in MTH 109 or 112; or qualifying score on math placement exam.
- MTH 116 Brief Calculus with Applications II** 3 hrs.  
(Gen. Ed. MA)  
Continuation of MTH 115. Includes trig functions, integration techniques, series, differential equations, and multivariable calculus. Prerequisites: C or better in MTH 115.
- MTH 118 Calculus with Review A** 4 hrs.  
Topics in analytic geometry, limits, continuity, derivative, and pertinent algebra review. Prerequisites: qualifying entrance and/or placement scores.
- MTH 119 Calculus with Review B** 4 hrs.  
(Gen. Ed. MA)  
Continuation of MTH 118. Topics in analytic geometry, definite integral, Fundamental Theorem of Calculus, and pertinent algebra review. Prerequisite: grade of C or better in MTH 118.
- MTH 120 Discrete Mathematics** 3 hrs.  
Introduction to graph theory, Boolean algebra, mathematical induction, and elementary combinatorics. Prerequisites: qualifying entrance and/or math precalculus placement scores as for MTH 121; or grade of C or better in MTH 112.
- MTH 121 Calculus I** 4 hrs.  
(Gen. Ed. MA)  
Topics in analytic geometry; limits; continuity; differentiation; introduction to integration; applications. Prerequisites: qualifying entrance and/or math precalculus placement scores; or grade of C or better in MTH 112.
- MTH 122 Calculus II** 4 hrs.  
(Gen. Ed. MA)  
Topics in calculus of logarithmic, exponential, and trigonometric functions; techniques of integration; analytic geometry; indeterminate forms; improper integrals; infinite series. Prerequisite: grade of C or better in MTH 119 or MTH 121 or its equivalent.
- MTH 190 Topics in Mathematics for Middle School Teachers** 3 hrs.  
Topics for middle school math teachers: analytic geometry, problem solving, topics in calculus. For elementary education majors only. May be repeated under different topics for a maximum of 6 hours credit. Prerequisite: consent of instructor.
- MTH 202 Introduction to Numerical Methods** 3 hrs.  
Introductory treatment of numerical methods used in the solution of scientific and engineering problems: approximations, interpolation, root finding, numerical integration, linear algebraic systems, first-order differential equations. Numerical and mathematical software will implement algorithms. Prerequisite: MTH 122.
- MTH 207 Elementary Linear Algebra with Applications** 3 hrs.  
Matrix algebra, determinants, theory of simultaneous equations, vector spaces, bases, Gram-Schmidt orthogonalization, eigenvalues, eigenvectors, transformations, and applications. Prerequisite: MTH 122, or consent of instructor.
- MTH 223 Calculus III** 4 hrs.  
(Gen. Ed. MA)  
Topics in vectors; calculus of functions of several variables; multiple integrals; vector calculus. Prerequisite: grade of C or better in MTH 122.

**MTH 224 Elementary Differential Equations 4 hrs.**

Solution of second order equations with constant coefficients; matrix algebra applied to the solution of first order systems; Laplace transforms; power series methods; numerical methods; modeling; applications. Prerequisite: MTH 223.

**MTH 300 Topics for Middle School Math Teachers 3 hrs.**

Topics of special interest which may vary each time course is offered, rotating among geometry, algebra/number theory, and history of mathematics. Topic stated in current Schedule of Classes. For middle school teacher certification; does not count for math majors or math minors. May be repeated under different topics for a maximum of 9 hours credit. Prerequisites: C or better in ETE 115 and ETE 225; C or better in calculus, computer programming, or statistics (MTH 111); or consent of instructor.

**MTH 301 Combinatorics 3 hrs.**

Combinatorial analysis, recurrence relations, generating functions, and finite-state machines. Prerequisites: MTH 120, 122; or MTH 223.

**MTH 302 Introduction to Graph Theory 3 hrs.**

Theory and applications of graphs. Fundamental properties of graphs, circuits, cycles, trees, and graph algorithms; planarity and coloring. Prerequisites: MTH 120, 122; or MTH 223.

**MTH 305 Modern Geometry 3 hrs.**

Modern geometry; methods similar to those used in plane geometry. Prerequisite: MTH 223.

**MTH 307 Linear Algebra 3 hrs.**

Vector spaces, linear transformations, inner product spaces, Jordan canonical forms, spectral theorems, and selected topics. Prerequisite: MTH 207.

**MTH 310 Introduction to Number Theory 3 hrs.**

Historical development of number theory; primes and their distribution; divisibility; unique factorization of integers; congruences; Diophantine equations; number theoretic functions. Prerequisite: MTH 223.

**MTH 325, 326 Probability & Statistics I, II 3 hrs. each**

Probability and statistical concepts, theory, and applications: random variables, sampling, central limit theorem, theories of estimation and the testing of hypotheses, linear models, and nonparametric methods. Prerequisite: MTH 223; MTH 325 required for MTH 326.

**MTH 335 Topics in Actuarial Science 3 hrs.**

Preparation for Actuarial Exams 140, 150. Topics may vary each time course is offered, rotating among compound interest, mathematics of life contingencies, and actuarial mathematics. Topic stated in current Schedule of Classes. May be repeated under different topics for a maximum of 9 hours credit. Prerequisites: MTH 207, MTH 223; consent of instructor.

**MTH 345 Differential Equations 3 hrs.**

Existence and uniqueness theorems; solution methods for initial and boundary value problems; linear and nonlinear systems; stability theory; difference equations. Prerequisites: MTH 207, 223; or consent of instructor.

**MTH 370 Mathematics Seminar 1 hr.**

Seminar course introducing various mathematical topics. Prerequisite: junior or senior standing; mathematics major or minor or consent of Department Chair.

**MTH 371 History of Mathematics 3 hrs.**

A survey of the historical development of mathematics from antiquity to the twentieth century. Emphasis will be on the interrelations between the various areas of mathematics as well as the mathematical content itself. Prerequisites: MTH 207 and 3 semester hours from courses numbered MTH 301 or above; or consent of instructor.

**MTH 390 Mathematical Modeling 3 hrs.**

Introduction to constructing and evaluating mathematical models for describing and analyzing real world phenomena. Continuous and/or discrete models. Prerequisite: MTH 223; consent of instructor.

**MTH 403 Complex Variables I 3 hrs.**

Introduction to complex calculus: elementary functions, integration, Cauchy's formula, residue theory, and applications. Prerequisites: MTH 207, 223; or MTH 224.

**MTH 404 Modern Algebra I 3 hrs.**

Basic theory of sets, integers, and mappings; elementary properties of groups, rings, and fields. Prerequisite: MTH 207, 223.

**MTH 405 Modern Algebra II 3 hrs.**

Topics selected from theory of rings, field theory, and applications. Prerequisite: MTH 404.

**MTH 406 Elementary Topology 3 hrs.**

Introduction to rudiments of point set topology. Concepts of compactness, connectedness, and continuity, in context of general topological spaces and metric spaces. Prerequisite: MTH 420, or consent of instructor.

**MTH 420 Introduction to Analysis 3 hrs.**

Real number system and functions of real variables: sequences, limits, continuity, differentiation, series, uniform convergence, and the Riemann-Stieltjes integral. Prerequisite: MTH 207, 223.

**MTH 421 Advanced Calculus 3 hrs.**

Functions of several variables. Calculus of transformations, implicit and inverse function theorems, line and surface integrals, Fourier analysis, fixed point theorems, and applications. Prerequisite: MTH 420 or consent of instructor.

**MTH 427 Applied Statistical Methods 3 hrs.**

Regression analysis, time series analysis, and forecasting. Prerequisites: MTH 326 or consent of instructor.

**MTH 490 Topics in Mathematics 3 hrs.**

Topics of special interest which may vary each time course is offered. Topic stated in current Schedule of Classes. Prerequisite: consent of instructor.

**MTH 491 Directed Individual Studies in Mathematics 1-16 hrs.**

Individual work in special areas of mathematics for advanced, qualified undergraduate students. May register for more than 6 hrs. credit only if enrolled in an approved special off campus program. Prerequisite: consent of Department Chair.

**MTH 494 Senior Project in Mathematics I 0 hrs.**

Topics in mathematics selected, studied, and discussed by students under faculty guidance. Each student explores an area of mathematics and selects a topic in which he or she has a particular interest. Prerequisite: Senior standing (junior standing with consent of instructor).

**MTH 495 Senior Project in Mathematics II 3 hrs.**

A selected topic in mathematics is studied by a student under faculty guidance. Each student writes a paper and gives a presentation on his or her topic. Prerequisite: MTH 494; senior standing.

**MTH 501 Topics in Applied Mathematics I 3 hrs.**

Theory, applications, and algorithms for basic problems of modern applied mathematics. Symmetric linear systems, minimum principles, equilibrium equations, calculus of variations, orthogonal expansions, and complex variables. Prerequisites: MTH 224 or 345.

**MTH 502 Topics in Applied Mathematics II 3 hrs.**

Continuation of MTH 501. Selected numerical algorithms: Fast Fourier transform, initial value problems, stability, z-transforms, and linear programming. Prerequisite: MTH 501 or consent of instructor.

**MTH 510 Numerical Methods I 3 hrs.**

Introduction to numerical and computational aspects of various mathematical topics: finite precision, solutions of non-linear equations, interpolation, approximation, linear systems of equations, and integration. Cross listed as CS 510. Prerequisite: CS 106; MTH 207 and 223.

**MTH 511 Numerical Methods II 3 hrs.**

Continuation of CS/MTH 510: further techniques of integration, ordinary differential equations, numerical linear algebra, nonlinear systems of equations, boundary value problems, and optimization. Cross listed as CS 511. Prerequisites: MTH 224 or 345; CS/MTH 510.

**MTH 514 Partial Differential Equations 3 hrs.**

Fourier series and applications to solutions of partial differential equations. Separation of variables, eigenfunction expansions, Bessel functions, Green's functions, Fourier and Laplace transforms. Prerequisite: MTH 224 or 345.