Mathematics

Department: Mathematics and Computing
Department Chair S. Hoehn
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Majors: Actuarial Science, Applied Mathematics, Pure Mathematics, Quantitative Analysis
Minors: Mathematics, Quantitative Methods
Related Major: Data Science
Related Minor: Data Science

Courses and majors in mathematics and computing are designed to provide students with fundamental knowledge of and facility with concepts and processes in mathematics and computing and to help develop interpersonal and lifetime learning skills so that they can adapt to new challenges and situations in their personal and professional lives. The department seeks to promote active learning in the classroom through the implementation of cooperative learning, discovery learning, and the incorporation of technology in a variety of hands-on experiences.

All required courses for a major or minor in mathematics or computing, including all related field and prerequisite requirements, must be completed with a *C*- or better. Prerequisites for non-majors must also be completed with a *C*- or better. Education students should consult that department for minimum requirements.

Majors in Mathematics
Students who pursue a major in mathematics may select one or more of the following curricular programs: pure mathematics, applied mathematics, actuarial science, and quantitative analysis. A 4+1 engineering program is also available in civil engineering, chemical engineering, and mechanical engineering. See the engineering section of this catalog for further details.

Pure Mathematics Major

Designed for students who are preparing for graduate school by providing a broad theoretical base

Core Requirements

MAT 135 Calculus
MAT 140 Introduction to the Mathematical Sciences
MAT 142 Calculus II
MAT 181 Discrete Mathematics I
MAT 182 Discrete Mathematics II
MAT 224 Basic Applied Statistics
MAT 233 Linear Algebra
MAT 253 Calculus III
MAT 343 Probability Theory
MAT 471 Senior Seminar
MAT 499 Senior Competency Practicum

Professional Development Requirements

PDP 200 Preparing for Your Internship
INT 261 Computing/Math/Statistics Internship

Pure Math Program Requirements

MAT 361 Modern Algebra
MAT 367 Introduction to Real Analysis
One additional MAT course at the 300-level

One of the following courses – *satisfies the senior year experiences requirement for graduation*

MAT 450 Guided Independent Research in Mathematics
MAT 490 Independent Study

Related Field Requirements

Computer modeling

CMP 141 Python for Computing and Data Science I
CMP 150 Computer Tools for Problem Solving

Two of the following courses

CMP 130 Introduction to Computing
CMP 142 Python for Computing and Data Science II
CMP 360 Operations Research

Three additional credit hours approved by the departmental advisor. Courses taken to meet liberal arts exploratory requirements cannot be included.

Actuarial Science Major

An interdisciplinary major consisting of coursework in mathematics, statistics and business designed for students interested in using quantitative methods to assess and manage risk, especially in a financial setting. Note: Not available to Quantitative Analysis majors.

Core Requirements

MAT 135 Calculus
MAT 140 Introduction to the Mathematical Sciences
MAT 142 Calculus II
MAT 181 Discrete Mathematics I
MAT 182 Discrete Mathematics II
MAT 224 Basic Applied Statistics
MAT 233 Linear Algebra
MAT 253 Calculus III
MAT 343 Probability Theory
MAT 471 Senior Seminar
MAT 499 Senior Competency Practicum

Professional Development Requirements

PDP 200 Preparing for Your Internship
INT 261 Computing/Math/Statistics Internship

Actuarial Science Program

MAT 344 Mathematical Statistics
MAT 352 Financial Mathematics
PDP 330 Big Data and the Professional Workplace

Computer Modeling Requirements

CMP 130 Introduction to Computing
CMP 141 Python for Computing and Data Science I
CMP 150 Computer Tools for Problem Solving

Economics, Business, and Accounting Requirements

ACC 221 Principles of Accounting I
ACC 222 Principles of Accounting II
BUS 351 Business Finance
BUS 353 Principles of Risk and Insurance
ECO 121 Principles of Microeconomics
ECO 123 Principles of Macroeconomics
ECO 221 Intermediate Microeconomics
ECO 223 Intermediate Macroeconomics

Recommended Course

ECO 380 Econometrics

Applied Mathematics Major

Designed for students interested in relating theoretical concepts with their applications in other disciplines and in industry (e.g. engineering and operations research).

Core Requirements

MAT 135 Calculus
MAT 140 Introduction to the Mathematical Sciences
MAT 142 Calculus II
MAT 181 Discrete Mathematics I
MAT 182 Discrete Mathematics II
MAT 224 Basic Applied Statistics
MAT 233 Linear Algebra
MAT 253 Calculus III
MAT 343 Probability Theory
MAT 471 Senior Seminar
MAT 499 Senior Competency Practicum

Professional Development Requirements

PDP 200 Preparing for Your Internship
INT 261 Computing/Math/Statistics Internship

Applied Math Program Requirements

MAT 345 Statistical Consulting Project
PDP 330 Big Data and the Professional Workplace

One of the following courses

MAT 256 Differential Equations
MAT 344 Mathematical Statistics

Two of the following courses

MAT 300 Topics in Mathematics
MAT 361 Modern Algebra
MAT 367 Introduction to Real Analysis

Related Field Requirements

Computer modeling

CMP 141 Python for Computing and Data Science I
CMP 150 Computer Tools for Problem Solving

One of the following courses

CMP 130 Introduction to Computing
CMP 142 Python for Computing and Data Science II
CMP 360 Operations Research

Nine additional credit hours selected by the student and approved by a departmental advisor. Courses taken to meet liberal arts exploratory requirements cannot be included.

Quantitative Analysis Major

Designed for students interested in exploring the relationships between mathematics and either marketing, finance, or economics. The list below includes the related field requirements. Note: Not available to Actuarial Science majors.

Core Requirements

MAT 135 Calculus
MAT 140 Introduction to the Mathematical Sciences
MAT 142 Calculus II
MAT 181 Discrete Mathematics I
MAT 182 Discrete Mathematics II
MAT 224 Basic Applied Statistics
MAT 233 Linear Algebra
MAT 253 Calculus III
MAT 343 Probability Theory
MAT 471 Senior Seminar
MAT 499 Senior Competency Practicum

Professional Development Requirements

PDP 200 Preparing for Your Internship
INT 261 Computing/Math/Statistics Internship

Quantitative Analysis Program

PDP 330 Big Data and the Professional Workplace

One of the following courses

MAT 256 Differential Equations
MAT 300 Topics in Mathematics
MAT 345 Statistical Consulting Project
MAT 352 Financial Mathematics
MAT 367 Introduction to Real Analysis

Computer Modeling Requirements

CMP 130 Introduction to Computing
CMP 141 Python for Computing and Data Science I
CMP 150 Computer Tools for Problem Solving
CMP 360 Operations Research

Economics, Business, and Accounting Requirements

ACC 221 Principles of Accounting I
ECO 121 Principles of Microeconomics
ECO 123 Principles of Macroeconomics

One of the following options

Economics Option

ECO 221 Intermediate Microeconomics
ECO 223 Intermediate Macroeconomics
ECO 380 Econometrics

Plus two of the following courses

ECO 330 Money and Banking
ECO 350 International Business & Finance
ECO 360 Labor Economics and Management

Finance Option

ACC 222 Principles of Accounting II
BUS 351 Business Finance
BUS 352 Investments

Plus one of the following courses

ECO 221 Intermediate Microeconomics
ECO 223 Intermediate Macroeconomics

Plus one of the following courses

BUS 353 Principles of Risk and Insurance
ECO 330 Money and Banking

Marketing Option

ACC 222 Principles of Accounting II
BUS 361 Contemporary Marketing
BUS 365 Digital Marketing

Plus one of the following courses

ECO 221 Intermediate Microeconomics
ECO 223 Intermediate Macroeconomics

Plus one of the following courses

ECO 380 Econometrics
PSY 320 Social Psychology

Data Science Major

Please see separate Data Science section in this course catalog.

Cooperative Program in Engineering (Chemical, Civic, Computer, and Mechanical Engineering)

Franklin College maintains a cooperative "4+1" program in engineering with the Witchger School of Engineering at Marian University. Students in this program will earn a Bachelor of Arts degree in Applied Mathematics at Franklin College, and then a Bachelor of Science degree in either Civil Engineering, Chemical Engineering, Computer Engineering, or Mechanical Engineering through the Witchger School of Engineering at Marian University.

Students opting to pursue the degree programs in Civil, Chemical, Computer, or Mechanical Engineering will major in Applied Mathematics at Franklin College and follow the Applied Mathematics course of study given above. Some course substitutions and choices of electives are necessary to complete the engineering portion of the program; details of these and other aspects of the cooperative program can be found in the Engineering section of the catalog.

Mathematics Minor

A minor which provides a broad overview of some of the primary areas of study in mathematics.

Core Requirements

MAT 135 Calculus
MAT 140 Introduction to the Mathematical Sciences
MAT 142 Calculus II
MAT 181 Discrete Mathematics I

Two of the following courses

MAT 182 Discrete Mathematics II
MAT 224 Basic Applied Statistics
MAT 233 Linear Algebra
MAT 253 Calculus III
MAT 256 Differential Equations
MAT 300 Topics in Mathematics
MAT 323 Mathematics for Elementary Teaching I
MAT 324 Mathematics for Elementary Teaching II
MAT 343 Probability Theory
MAT 345 Statistical Consulting Project
MAT 361 Modern Algebra
MAT 363 Topics in Geometry
MAT 367 Introduction to Real Analysis

Quantitative Methods Minor

A minor geared toward students majoring in the social sciences or humanities. Students majoring in mathematics or computer science may not elect this minor.

The following course

MAT 224 Basic Applied Statistics

Twelve credit hours from the following courses

CMP 130 Introduction to Computing **or** **CMP 141** Python for Computing and Data Science I
CMP 150 Computer Tools for Problem Solving
CMP 360 Operations Research
ECO 380 Econometrics
LA 103 Quantitative Reasoning OR **MAT 131** Introduction to Quantitative Analysis
MAT 135 Calculus
MAT 181 Discrete Mathematics I
MAT 182 Discrete Mathematics II
MAT 233 Linear Algebra
MAT 300 Topics in Mathematics
MAT 345 Statistical Consulting Project
PDP 330 Big Data and the Professional Workplace

Data Science Minor

Please see separate Data Science section in this course catalog.

Mathematics Course Descriptions

MAT 115 Math Study Center Theory and Practice		1 credit hour
Fall		

This course will prepare students to work as associates in the Math Study Center. It will include readings and discussion on the fundamentals of tutoring mathematics, mock tutoring sessions, and discussion on tutoring theory and practice. Required for all new Math Study Center associates.

MAT 131 Introduction to Quantitative Analysis		4 credit hours*
Fall and spring		Note: Placement into CMP 130/LA 103/MAT 131 based upon mathematics placement criteria

This course is designed for students who either intend to enroll in MAT 135 or MAT 181 in a subsequent semester or who intend to pursue a degree in economics, business, or accounting. Students will study families of functions and learn how to use them to solve real-world problems. The course will include the mathematics of finance, systems of linear equations and inequalities, logic, sets, and probability. These mathematics skills are essential to the areas of economics, business, accounting, and computing. The course will finish with an introduction to limits and derivatives of a function. Students wishing to pursue an Economics, Business, or Accounting degree with prior credit for MAT 135 or MAT 181 must pass a financial mathematics competency exam, earning a C- (68%) or better, for the MAT 131 requirement to be waived.

***<u>Note</u>: This course does not satisfy the liberal arts mathematics requirement.**

MAT 135 Calculus		4 credit hours
Fall and spring	Fulfills LA 103 requirement	Note: MAT 131 or placement into MAT 135/181/224 based upon mathematics placement criteria

The concept of differentiation is developed using limits and focusing on algebraic, exponential, and logarithmic functions. Applications of derivatives in the sciences and economics are presented, and an introduction to integration concludes the course. The mathematics is presented from analytical, graphical, and numerical perspectives, with extensive use of technology.

MAT 140 Introduction to the Mathematical Sciences		1 credit hour
Fall		Prereq or coreq: MAT 135

An introduction to mathematical processes, methods of problem solving, topics of current interest in mathematics, and the role of mathematics in the workplace. Some topics will extend and supplement the content of MAT 135 Calculus.

MAT 142 Calculus II		4 credit hours
Spring		Prereq: MAT 135 and MAT 140 or consent of instructor

A continuation of MAT 135. Course material includes the rotation of functions in three-dimensional space, applications and techniques of integration, the convergence and divergence of sequences and series, and parameterization.

MAT 181 Discrete Mathematics I		3 credit hours
Fall	Fulfills LA 103 requirement	Note: MAT 131 or MAT 224 or placement into MAT 135/181/224 based upon mathematics placement criteria

This course provides a foundation for the study of discrete (finite) structures. The course focuses heavily on proof techniques and style, including proof by contradiction and proof by contraposition. Boolean algebra and propositional logic make up a large portion of the semester. Additional topics include introductory set theory, methods of counting, and basic probability, including the ideas of expected value and variance. There is also heavy emphasis on the use of typesetting technology, making this course attractive for those considering graduate school in mathematics, computing or the natural sciences.

MAT 182 Discrete Mathematics II		3 credit hours
Spring		Prereq: MAT 181

This course continues, using the content of MAT 181, to delve into discrete topics. Proof by induction is introduced and used throughout the semester. Other topics include properties of the integers, modular arithmetic, relations, and discrete structures, including graphs and trees.

MAT 224 Basic Applied Statistics		3 credit hours
Fall and Spring	Fulfills LA 103 requirement	Prereq: one of the following: CMP 130, LA 103, MAT 131, MAT 135, MAT 181, or placement in MAT 135/181/224

An introduction to statistical reasoning for the natural and social sciences using the computer as a tool to analyze data. Probability concepts, sampling theory, hypothesis testing, estimation, chi-square, t-test, analysis of variance, correlation and regression, and some non-parametric tests are included. Minitab or another statistical package will be used. Same as SOC 224. Students cannot receive credit for both.

MAT 233 Linear Algebra		4 credit hours
Spring		Prereq: MAT 142 or MAT 181 Prereq or coreq: CMP 150 or consent of instructor

The study of systems of linear equations: the determination of whether a system has no, one, or infinitely many solutions and the techniques for obtaining such solutions. The topics include Gaussian elimination, linear independence, matrix algebra, determinants, vector spaces, linear transformations and their matrix representations, spanning sets and bases, rank, eigenvalues and eigenvectors, and orthogonality and least squares. Incorporates use of Matlab software. The course also includes the development and explanation of applications of those concepts and a study of the role of proof in linear algebra with emphasis on reading and writing proofs and using mathematical results to draw conclusions.

MAT 253 Calculus III		4 credit hours
Fall		Prereq: MAT 142 and CMP 150 or consent of instructor

Multidimensional calculus. Vectors, partial derivatives, multiple integrals, alternative coordinate systems, vector fields and line and flux integrals, with applications to volumes, optimization, and motion. Incorporates use of computer algebra system for graphics display and symbolic manipulation. Includes topics in analytic geometry.

MAT 256 Differential Equations		3 credit hours
Spring, odd academic years		Prereq: MAT 142

A study of ordinary differential equations, their applications, and selected methods of solutions both in closed form and by numerical methods. Includes qualitative methods and use of computer technology.

MAT 300 Topics in Mathematics		3 credit hours
Spring, even academic years		Prereq: MAT 142 and MAT 181 or consent of instructor

A topic of current interest in mathematics will be taught. Topics will vary depending on faculty interest.

MAT 323 Mathematics for Elementary Teaching I		2 credit hours
Fall, junior year		Prereq: LA 103; Coreq: EDE 336, EDE 344, EDE 365 & EFE 384; Additional prereq: 2.50 GPA & admission to the teacher education program

This course is the first foundational course in the mathematics content area for elementary education majors. It includes problem solving, sets, functions, exploration of our number system including properties, place value, basic operations and algorithms, and basic concepts of algebra. Problem solving is stressed in each unit. The NCTM Principles and Standards and Indiana's Academic Standards for Mathematics are introduced.

MAT 324 Mathematics for Elementary Teaching II		2 credit hours
Spring, junior year		Prereq: MAT 323; Coreq: EDE 337, EDE 345, EDE 366 & EFE 385; Additional prereq: 2.50 GPA & admission to the teacher education program

This course is the second foundational course in the mathematics content area for elementary education majors. It includes exploration of our number system including properties, basic operations and algorithms, probability, statistics, measurement, coordinate geometry, graphs, and 2- and 3-dimensional geometry. Problem solving is stressed in each unit. The NCTM Principles and Standards and Indiana's Academic Standards for Mathematics are introduced.

MAT 343 Probability Theory		3 credit hours
Fall, odd academic years		Prereq: CMP 150, MAT 142, & MAT 181

An introduction to probability theory, the part of mathematics that studies random phenomena. We model simple random experiments mathematically and learn techniques for studying these models. Topics covered include a review of combinatorics, axioms of probability, discrete and continuous random variables, common probability distributions, expectations, moment generating functions, conditional probability and conditional expectations, multivariate distributions, covariance, laws of large numbers, and the central limit theorem.

MAT 344 Mathematical Statistics		3 credit hours
Spring, odd academic years		Prereq: MAT 224 & MAT 343

A calculus-based course that examines the theoretical foundations of sampling and statistical inference, together with their applications to real-life data. Topics will include sampling theory, properties of estimators, confidence intervals, hypothesis testing, and nonparametric tests. Regression analysis will be covered in-depth. The statistical package R will be used to analyze data sets.

MAT 345 Statistical Consulting Project		3 credit hours
Spring	Civic Learning Exploratory	Prereq: MAT/SOC 224

Each student will work as part of a team to complete a statistical consulting project for a local non-profit agency or other appropriate organization. Special emphasis will be given to the development of skills in project management and consulting. Projects will be chosen to require the use of important statistical concepts such as experimental design, survey design, or regression analysis. Recommended especially for majors in the social sciences who are intending to go to graduate school or for those aiming for careers involving statistical applications. Same as ECO/PSY/SOC 345. Students may receive credit in only one of these cross-referenced courses.

MAT 352 Financial Mathematics		3 credit hours
Fall, even academic years		Prereq: MAT 142 & MAT 182

A calculus-based course that provides an introduction to the fundamental concepts of financial mathematics and how those concepts are applied in calculating present and accumulated values for various streams of cash flows. Major topics will include the mathematical foundations of interest rate measurement, annuities, loans, bonds, general cash flows, immunization, interest rate swaps, and determinants of interest rates. The topics in this course serve as the foundation for the second actuarial exam, Exam 2/FM Financial Mathematics.

MAT 361 Modern Algebra		3 credit hours
Fall, odd academic years		Prereq: MAT 142, MAT 182 & CMP 150 or consent of instructor

Overview of the concepts and applications of algebraic structures. Major topics include basic number theory and modular arithmetic; groups, subgroups and cyclic groups; permutations and dihedral groups; and isomorphisms and homomorphisms. In addition, applications to cryptography and the encoding, transmission, and error-correction of data are also examined.

MAT 363 Topics in Geometry		3 credit hours
On demand		Prereq: MAT 142, MAT 182 & CMP 150 or consent of instructor

An introduction to modern geometric concepts, including foundations of geometry and non-Euclidean geometry. Incorporates use of computer software to illustrate and explore geometric concepts.

MAT 367 Introduction to Real Analysis		3 credit hours
Fall, even academic years		Prereq: MAT 142, MAT 182 & CMP 150 or consent of instructor

An introduction to the theory of functions of a real variable, including limits, continuity, derivatives, integration theory, and sequences and series.

MAT 450 Guided Independent Research in Mathematics		1 credit hour
On demand		Prereq: senior standing or consent of instructor

A semester-long research experience in a mathematical topic of interest. Students will attend an intensive short course held during the first three weeks of the semester and then work with the instructor to develop questions for mathematical investigation. Students then investigate their questions throughout the semester utilizing appropriate mathematical research and problem-solving techniques. Student work will culminate in a public presentation of their research. Students may receive credit for this course through departmentally-approved activities such as participation in REU programs, although all students must participate in the public presentations. Offered only upon demonstration of sufficient demand and with approval of the Vice President of Academic Affairs.

MAT 471 Senior Seminar		3 credit hours
Fall		Prereq: senior standing & departmental consent; Coreq: MAT 499

A capstone course focusing on a re-examination of major mathematical concepts and their relationships and development. A study of the history and philosophy of mathematics establishes a frame within which students prepare for the senior competency exam. Emphasizes individual and team student presentations. Satisfies the senior year portfolio requirements for graduation.

MAT 482 Mathematics Practicum		1-2 credit hours

A supervised, pre-approved experience which allows a student to pursue specific learning goals and/or be involved in a field experience during the regular academic semester.

MAT 490 Independent Study		1-2 credit hours
		Prereq: departmental consent

Courses are designed to encourage student initiative and to provide a degree of flexibility in the departmental program. Normally the subject is not sufficiently or appropriately covered in departmental course offerings. Course work is planned by student and instructor jointly to meet student's individual needs.

MAT 499 Senior Competency Practicum		No credit
Fall		Coreq: MAT 471

The senior competency practicum consists of three components. The first component, the joint written comprehensive exam, requires students working in teams to prepare written responses to a set of approximately five questions posed by an outside evaluator. Responses may require experimentation involving computer technology, writing proofs, modeling real situations, and using library and information resources. The second component is an oral examination by three faculty members involving fundamental concepts encountered in the student's major and the relationships between them. The third component is the Major Field Achievement Test in Mathematics, a nationally-normed multiple-choice examination. Students must earn a *C*- on the oral component and a *C* or higher in the entire senior comprehensive practicum.

PDP 330 Big Data and the Professional Workplace		3 credit hours
Spring, even academic years		Prereq: (CMP/DAT 141 or CMP 150), PDP 200 & MAT/SOC 224

This course provides an introduction to the field of statistical learning and the essential tools for making sense of large and complex data sets. The topics include linear regression, classification, resampling methods, shrinkage methods, and tree-based methods. Students will work in teams, each under the coaching of an alumni professional who will serve as an advisor during the project, lead discussions regarding the demands of the professional workplace, and provide individual feedback on the degree to which each student displays professional skills and dispositions. Most of the project work will be conducted in an online environment to provide students with a taste of the conditions experienced by telecommuting professionals.

SNT 489 (MAT) Professional Development Internship in Math		7-10 credit hours
		Prereq: Senior standing or permission of instructor

A semester-long internship requiring 20-30 hours per week on-site under the supervision of a practicing professional and a member of the mathematics faculty. Each student will be responsible to ensure that required reports and other submissions are completed by the scheduled dates. Grading will be on a pass-fail basis.