

MATHEMATICS

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Academic Programs	Credits
BS: Mathematics	39
BS: Mathematics Education	36
Major in Mathematical Studies	30
Minor in Mathematics	20
Minor in Mathematics Education	20
Minor in Mathematics of Economics and Finance	20

Mission

Through teaching, research and service, the Department of Mathematics seeks to provide leadership in the mathematical sciences by preparing students with the mathematical understanding, problem-solving skills and dispositions that enable them to excel in their chosen careers; increasing mathematical and scientific knowledge through publication and presentation; supporting the broader mathematics education community; and mentoring others for generous service through a committed Christian life.

Mathematics is foundational to physics, engineering, and computer science, and is increasingly important in many fields of study such as finance, accounting, economics, biology, medicine, and environmental science. Students majoring in these and other fields will find that acquiring an additional major in mathematics or mathematical studies greatly enhances the marketability of their degree.

Undergraduate Programs

BS: Mathematics (39)

MATH191 (or 195), 192, 215, 240, 286, 355; MATH 315 or 441; MATH389 or PHYS277 (4 semesters); STAT340 and at least 12 credits in additional courses chosen in consultation with a Department of Mathematics advisor from MATH271, 315, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495. Students in a secondary teacher certification program are required to take MATH375, 475 and STAT285. (Note that MATH375 and STAT285 do not count

toward the 39 major credits.) A major field test in mathematics is required during the senior year.

Cognate Course—3

CPTR125, 151 or PHYS235

Major in Mathematical Studies (30)

MATH191 (or 195), 192, 215, 240; MATH389 or PHYS277 (4 semesters), and at least 15 credits in additional courses chosen in consultation with a Department of Mathematics advisor from MATH271, 286, 315, 355, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495; STAT340; CPTR125, 151 or PHYS235 (3). A major field test in mathematics is required during the senior year. This major is available only as a second major, to those taking a major in another field.

Minor in Mathematics (20)

MATH191 (or 195), 192, 215 and at least 9 credits in additional courses chosen in consultation with a departmental advisor from MATH240, 286, 315, 355, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495; STAT340. Students in a secondary teacher certification program are required to take MATH355, 375, 475, STAT285, 340 and a major field test in mathematics during the senior year.

BS: Mathematics Education (36)

MATH191 (or 195), 192, 215, 240, 355, 375, 475; MATH 315 or 441; MATH286 or 426; MATH389 or PHYS277 (4 semesters); STAT285, 340. Students in an elementary teacher certification program take MATH220 instead of MATH375. This major is available only to those who are obtaining elementary or secondary teacher certification. A major field test in mathematics is required during the senior year.

Cognate Course—3

CPTR125, 151 or PHYS235

General Education Requirements—for Mathematics Education with Secondary Certification

See professional program requirements, p. 51, and note the following **specific** requirements:

Religion: 12*—RELT100, 225, RELH400 and a 3-credit elective chosen in consultation with your SED advisor

Language/Communication: ENGL115, 215, COMM450

Foreign Language (BA only)—Intermediate Language (4)

History: HIST117, 118

Fine Arts/Humanities: Choose one course from:

ARTH220, PHOTO210, Studio Art (3), ENGL255, PHIL224, MUHL214, Ensemble Music (3)

Life/Physical Sciences: professional degree requirements

Mathematics: Covered in major

Computer Literacy: INFS120

Service: EDTE165

Social Sciences: GDPC302 & EDTE228

Fitness Education: HLED120 plus two Fitness Education courses

Minor in Mathematics Education (20)

MATH166, 167, 191 (or 195), 215, 220, 355; STAT285. (MATH168 may be taken in place of MATH166, 167.) This minor is available only to

those obtaining elementary teacher certification. The minor listed above will also suffice for elementary certification.

Minor in Mathematics of Economics and Finance (20)

MATH191 (or 195), 192, 215, 286, STAT285, 340. This minor is available only to students obtaining a degree in the School of Business Administration.

Behavioral Neuroscience

The Department of Mathematics is a participant in the Behavioral Neuroscience program funded by the National Science Foundation. For more details, see p. 115.

Special Requirements and Placement Test

Sequential Course Numbering. All courses with more than one course number must be taken sequentially.

Non-overlapping Credit Restrictions. Because there is substantial overlap in material covered in the following groups of courses, no student is granted credit (other than general elective credit) in more than one course from each group:

1. MATH182, 191, 195 (Calculus with Applications, Calculus I, Calculus I for Biology)
2. MATH145, 166, 168 (Reasoning with Functions, Precalculus Algebra, Precalculus)

Minimum grade for prerequisites, except for MATH191 and 195, is C-.

Mathematics Placement Examination (MPE). See p. 48 for information on the MPE and the General Education Mathematics requirement. The MPE score is valid as a prerequisite for mathematics courses for 3 years after it is earned.

Graduate Program

MS: Mathematics and Science

The Department of Mathematics collaborates with the Departments of Biology, Chemistry, and Physics in this degree. See Mathematics and Science, p. 190.

Courses

See inside front cover for symbol code.

(Credits)

Developmental Courses

MATH091 and MATH092 are provided for students not achieving a score of at least P2 on the Mathematics Placement Examination (MPE).

Students complete the sequence MATH091/092 by passing a set of proficiency tests in arithmetic and algebra, at which time a P2 score is awarded. When this occurs, the student has completed the Math Skill part of the General Education requirement, and is considered ready to take MATH 145, 166, 168, or STAT285. Depending on the diligence and previous preparation of the student, this may occur at any time in the MATH091/092 sequence.

MATH091 \$ (3)

Arithmetic and Algebra Review I

Individualized review of arithmetic and algebra skills. Algebra topics include linear, quadratic and rational equations; graphs and systems of linear equations; and polynomial operations and factoring. Students completing the sequence requirements while enrolled in MATH091 are not required to take MATH092. This developmental course does not count toward college credit. *Fall, Spring*

MATH092 \$ (3)

Arithmetic and Algebra Review II

Continuation of MATH091. Students not completing the sequence requirements but fulfilling attendance, participation, and progress requirements may receive an R grade requiring re-registration the next semester. This developmental course does not count toward college credit. Prerequisite: MATH091. *Fall, Spring*

Undergraduate Courses

MATH145 (3)

Reasoning with Functions

Functions given by tables, formulas, graphs, and words; inverse functions; linear, exponential, and other types of functions, such as quadratic, trigonometric, logarithmic, or power functions; rates of change and applications to science and business. Additional topics may be selected by the instructor. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2. *Fall, Spring*

MATH165V C (3)

College Algebra

Paper correspondence course. A study of linear equations and inequalities; algebraic, logarithmic, and exponential functions; polynomials and complex numbers. Includes applications in business and science. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2.

MATH166 (3)

Precalculus Algebra

Equations and inequalities; systems of linear equations; algebraic, polynomial, rational, exponential, and logarithmic functions; inverse functions, complex numbers, applications, and selected topics. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2. *Fall, Spring*

MATH167 Alt (2)

Precalculus Trigonometry

Trigonometric functions and their inverses, identities, trigonometric equations; laws of sines and cosines, vectors, applications, and selected topics. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P3 or MATH166 or MATH145. *Fall, even years*

MATH168 (4)

Precalculus

Covers most of the content of MATH166 and MATH167. Equations and inequalities; systems of linear equations; algebraic, polynomial, rational, exponential, and logarithmic functions; inverse functions, complex numbers, trigonometric functions and their inverses, identities, trigonometric equations, laws of sines and cosines, vectors, applications, and selected topics. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2. *Fall, Spring*

- MATH168V** C (4)
Precalculus
 Paper correspondence course—see content above. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2.
- MATH182** Alt (3)
Calculus with Applications
 Introduction to single-variable calculus, including limits, differentiation, optimization, and integration with applications to problems in business and the social sciences. Some topics from multivariable calculus, including partial derivatives and extrema of functions of two variables. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P4 or MATH166, 167 or 168.
- MATH191** (4)
Calculus I
 MATH191, 192 is a standard introduction to single-variable calculus. MATH191 includes limits, continuity, derivatives, applications and integration up through substitution and integration by parts. Formal definitions of limit, derivative, and Riemann integral. Proofs of standard theorems, including the Fundamental Theorem of Calculus. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE=P5 or MATH167 or MATH168 with grade no lower than C. *Fall, Spring*
- MATH192** (4)
Calculus II
 Continuation of MATH191. Techniques of integration, improper integrals, applications of integrals, sequences, power series, Taylor and Maclaurin series, tests of convergence, error estimates, polar coordinates, parameterized curves, vectors, dot and cross products. Prerequisite: MATH191 or 195. *Spring*
- MATH195** (4)
Calculus I for Biology
 Introduction to single-variable calculus in the context of the life sciences from the dynamical systems point of view. Limits, continuity, derivatives, integration by substitution and by parts. Formal definitions of limit, derivative, and Riemann integral. Proofs of standard theorems, including the Fundamental Theorem of Calculus. In addition to standard topics, includes research applications to biology and medicine, an introduction to mathematical models and differential equations, equilibria, stability, and eigenvalues. Equivalent to MATH191 in serving as prerequisite to higher-level courses. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE=P5 or MATH167 or MATH168 with grade no lower than C; pre- or corequisite: BIOL165 or 166 or consent of the instructor. *Spring*
- MATH215** (3)
Introduction to Linear Algebra
 Vectors, Euclidean n -space, matrices, systems of linear equations, determinants, eigenvalues, eigenvectors, vector spaces, and linear transformations with emphasis on applications and computation. Prerequisites: MATH182, 191 or 195. *Fall*
- MATH220** Alt (3)
Geometry and Numbers
 Number systems and Euclidean geometry for elementary and middle school teachers. Topics include problem solving, reasoning and proof, computational algorithms, analysis and classification of geometric figures, geometric transformations, and other selected topics. Prerequisite: MPE \geq P2. *Fall, odd years*
- MATH240** (4)
Calculus III
 Standard introduction to multivariable calculus. Vectors and vector functions, curves and surfaces, partial derivatives, multiple integrals, line and surface integrals. Stokes', Green's, and divergence theorems. Prerequisite: MATH192. *Fall*
- MATH286** (3)
Differential Equations
 Ordinary differential equations as dynamical systems. Linear and nonlinear first order equations and systems, higher order linear equations, modeling, standard analytic and qualitative methods of solution, equilibria and stability, phase plane analysis. Computer graphing tools will be used. Prerequisite: MATH192. *Spring*
- MATH295** (1-3)
Independent Study
 Independent study of selected topics in mathematics under the supervision of a mathematics professor. Ordinarily a minimum of three hours of study per week is expected for each credit. The instructor may require written reports or oral presentations. Repeatable. Prerequisite: Consent of the instructor.
- MATH315** Alt (3)
Linear Algebra
 Vector spaces, eigenspaces, linear transformations, orthogonality, inner product spaces, quadratic forms, and selected topics. Prerequisites: MATH215, 355. *Spring, even years*
- MATH355** (3)
Discrete Mathematics
 Selected topics in discrete mathematics, including logic, set theory, relations, functions, properties of integers, modular arithmetic, and RSA encryption. Mathematical reasoning and the writing of proofs will be emphasized. Prerequisite: MATH182, 191 or 195. *Spring*
- MATH375** Alt (3)
Secondary School Mathematics Teaching
 Content, methods and materials for secondary school mathematics teaching, including secondary mathematics content, mathematical problem solving, lesson preparation, teaching of skills and concepts, use of technology, assessment of learning, issues in teaching and learning, and other selected topics. Prerequisite: MATH355. *Spring, odd years*
- MATH389** \$ (0)
Mathematics Colloquium
 Participation in at least 10 departmental colloquia or approved colloquia of other departments. Meets weekly, grade is based on attendance. Repeatable. *S/U. Fall, Spring*
- MATH405** ♦ Alt (3)
Applied Mathematics
 Solutions of first and second order partial differential equations, and applications. Prerequisites: MATH240, 286. *Fall, even years*
- MATH408** ♦ Alt (3)
Complex Analysis
 Elementary complex analysis, contour integrals, complex series. Prerequisites: MATH240, 355. *Spring, odd years*

MATH426 ♦ Alt (3)
Mathematical Modeling in Biology
 Theory and application of linear and nonlinear mathematical models of biological processes. Topics selected from discrete- and continuous-time deterministic and stochastic modeling, analytic solution techniques, linearization, bifurcations, chaos, computer simulation, model parameterization, and model validation. Prerequisite: MATH191 or 195. *Fall, odd years*

MATH431, 432 ♦ Alt (3, 3)
Advanced Calculus
 Theorems on continuity, differentiation, integration, and convergence; additional selected topics such as topology, differentiable manifolds, and real analysis. Prerequisites: MATH240, 355. *Fall, odd years; Spring, even years*

MATH441, 442 ♦ Alt (3)
Abstract Algebra
 Study of groups, rings, fields, modules, vector spaces, and algebras. Prerequisites: MATH240, 355. MATH441 is offered *Spring, odd years; MATH442 as needed*

MATH475 ♦ Alt (3)
Geometry
 Axiomatic development and history of Euclidean and non-Euclidean geometries, constructions, geometric transformations, and selected topics from finite, fractal, affine, and projective geometries. Relation of these topics to secondary teaching. Prerequisite: MATH355. *Fall, even years*

MATH487 Alt (1–3)
Special Topics in _____
 Consult the instructor in regard to the topic to be covered. Prerequisite: Consent of the instructor. Repeatable in different areas.

MATH495 (1–3)
Independent Study
 Independent study of selected topics in mathematics to enable advanced students to pursue topics not offered in other scheduled courses. The student will study under the supervision of a mathematics professor whose prior approval is required. Ordinarily a minimum of three hours of study per week is expected for each credit. Grades are assigned on the basis of an instructor-selected procedure such as oral or written exams or reports. Prerequisite: Consent of the instructor.

Statistics

STAT285 (3)
Elementary Statistics
 A study of basic descriptive and inferential statistics, including elementary probability and probability distributions, statistical inference involving binomial, normal, and *t*-distributions, and hypothesis testing. Prerequisite: MPE ≥ P2. *Fall, Spring*

STAT285V C (4)
Elementary Statistics
 Paper correspondence course—see content above. Prerequisite: MPE ≥ P2.

STAT340 (3)
Probability Theory with Statistical Applications
 Probability theory and statistics for students having preparation

in calculus. Topics include probability models, combinatoric problems, random variables, discrete and continuous distributions, expectation, moment generating functions, central limit theorem. Prerequisite: MATH191 or 195. *Spring*

Honors

MATH271-50 (1)
Honors in Mathematics
 The study of mathematical problems where the solution depends more on insight and creativity than on routine computation. Repeatable to 2 credits. Prerequisite: MATH192 and consent of the instructor.

Graduate Courses

MATH530 (2-3)
Topics in Teaching Mathematics
 A. Algebra
 B. Geometry
 C. Analysis
 D. Applications
 Consult with department chair regarding availability in any given year. Repeatable to 6 credits.

MATH540 Alt (2-3)
Topics in Mathematics
 Consult with the instructor in regard to the topic to be covered. Prerequisite: Consent of the instructor. Repeatable to 6 credits.

Mathematics Education Courses

The Department of Mathematics collaborates with the School of Education and Berrien Regional Education Service Agency to offer these courses when funding is available. The type of funding may place restrictions on enrollment in these courses. Inquiries should be directed to one of the following individuals:
 Larry Burton 269-471-3465, burton@andrews.edu
 Lynelle Weldon 269-471-3866, weldon@andrews.edu

MAED505 (2–3)
Understanding Numbers and Operations for Middle Grades Educators
 This course is designed to strengthen middle school teachers' rational number knowledge and number sense. This includes the in-depth study of rational numbers and operations on rational numbers, the structure of the rational and real number systems, algorithms for computation, estimation strategies, and working with very large and very small numbers. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED510 (3)
Exploring Algebra and Functions for Middle Grades Educators
 This course extends the middle school teachers' understanding of algebra as a symbolic language. This course moves beyond symbol manipulation to include modeling of physical situations. Students will explore algebraic, linear, and non-linear functions within the context of the course. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED515 (3)
Data Analysis for Middle Grades Educators
 This course presents an integrated approach to data analysis, statistics, and probability for middle grades math teachers. Instruction focuses on specific real-world data sets and statistical

investigations. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED521 (2)
Informal Geometry and Measurement for Middle Grades Educators

This course is the first of two which lead prospective mathematics teachers through a series of explorations to develop competence in geometric reasoning, including conjecture, proving, and disproving. Prospective teachers develop a deeper understanding of the role of proof in geometry. The pedagogy of this course models that of effective middle school mathematics teachers.

MAED522 (2)
Formal Geometry for Middle Grades Educators

This course is the second of two which lead prospective mathematics teachers through a series of explorations to develop competence in geometric reasoning, including conjecturing, proving, and disproving. Prospective teachers refine their understanding of the role of proof in geometry. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED600 (2)
Discrete Mathematics and Number Theory for Middle Grades Educators

Students investigate concepts of number theory, discrete mathematics, and logic as they apply to middle grades mathematical education. Each topic includes a study of graphic representation of concepts and applications in technology. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED610 (4)
Mathematical Modeling for Middle Grades Educators

Investigation of concepts and practices of mathematical modeling with an emphasis on application to middle grades education. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED625 (2)
Mathematical Investigations for Middle Grades Classrooms

Participants investigate topics in mathematics, including probability, programming, fractals, and chaos theory. Emphasis is placed on participant understanding of these topics and their appropriate use as investigations with middle grades students. The pedagogy of the course models that of effective middle school mathematics teachers.

MAED 630 (1-4)
Seminar: _____

Seminar in specific topics relevant to mathematics education. Each seminar examines one topic in detail. Repeatable with different topics. May be graded S/U.

MATHEMATICS & SCIENCE

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Desmond H. Murray, Chemistry
Marlene N. Murray, Biology
D. David Nowack, Chemistry
Yun Myung Oh, Mathematics
S. Clark Rowland, Physics
David A. Steen, Biology
Tiffany Z. Summerscales, Physics
Stephen C. Thorman, Physics, Computer Science
Lynelle M. Weldon, Mathematics
Robert E. Zdor, Biology

Mission

Inspire and equip students to celebrate learning, sense the action of God in the Universe, extend their analytical skills and knowledge base in mathematics and science, and identify and seek solutions to scientific issues.

MS: Mathematics and Science

The Master of Science: Mathematics and Science is designed for students who wish to acquire a breadth of knowledge which cannot be achieved within any one discipline among mathematics, biology, chemistry and physics. Such a degree may be useful for secondary or middle-school teachers who teach mathematics and science subjects, but who do not desire a traditional MAT program; for those who wish to develop skills in areas of overlap in these disciplines; for those who wish to study the interrelationships among the disciplines; and for those who wish further preparation for careers in industry or government.

In addition to the general requirements for admission to and enrollment in graduate degree programs outlined in this bulletin, students must meet departmental requirements.

Admission Requirements

- A bachelor's degree with a major in Mathematics, Biology, Chemistry, or Physics, and a minimum GPA of 3.00 (B) in mathematics and science courses.
- Completed the GRE General Exam for admission to regular student status. Completion of the GRE Subject Exam in one of the four areas of Mathematics, Biology, Chemistry or Physics is recommended.
- Earned credit or demonstrated proficiency in the following prerequisites: CPTR125 or 151 or PHYS235; MATH191 or 195, 192,