Graduate Courses
The following courses are available to those preparing for degree language examinations or for improvement in reading ability:

**FREN05**
*Reading French*
For students without a working knowledge in French; an introduction to the grammar and syntax of French for the purpose of translating written French into English. May count toward a general elective only.

**GRMN05**
*Reading German*
For students without a working knowledge in German; an introduction to the grammar and syntax of German for the purpose of translating written German into English. May count toward a general elective only.

**INLS75**
*Topics in _______
A study of selected topics in language, literature, or civilization. Topics and credits to be announced. Repeatable with different topics.

**INLS90**
*Directed Study/Reading/Research/Project*
Studies in the area of French/Spanish language, literature, or civilization, as determined in consultation with the instructor.

**Academic Programs**

<table>
<thead>
<tr>
<th>Program</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>BS: Mathematics</td>
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<tr>
<td>Applied Mathematics</td>
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<tr>
<td>Preparation for Secondary School Mathematics</td>
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<tr>
<td>Teaching</td>
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<tr>
<td>Preparation for Graduate Study in Mathematics</td>
<td></td>
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<tr>
<td>BS: Mathematics Education</td>
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</tr>
<tr>
<td>Major in Mathematical Studies</td>
<td>30</td>
</tr>
<tr>
<td>Minor in Mathematics</td>
<td>20</td>
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<tr>
<td>Minor in Mathematics Education</td>
<td>20</td>
</tr>
<tr>
<td>Minor in Mathematics of Economics and Finance</td>
<td>20</td>
</tr>
</tbody>
</table>

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**
MATH141, 142, 215, 240, 286, 315, 355; STAT340 and at least 12 credits in additional courses chosen in consultation with a Mathematics Department advisor from MATH271, 389, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495, CPTR436. Students in a teacher certification program are required to take MATH475. A major field test in mathematics is required during the senior year.

**Cognate Course:** CPTR125
Major in Mathematical Studies—30
MATH141, 142, 215, 240 and at least 15 credits in additional courses chosen in consultation with a Mathematics Department advisor from STAT340, CPTR125, MATH271, 286, 315, 355, 389, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495, CPTR436. 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
MATH141, 142, 215 and at least 9 credits in additional courses chosen in consultation with a departmental advisor from MATH240, 286, 315, 355, 389, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495; STAT340, CPTR436. Students in a teacher certification program are required to take MATH355, 475, STAT340.

BS: Mathematics Education—30
MATH141, 142, 215, 240, 355, 475; STAT285, 340 and one additional course chosen in consultation with a Mathematics Department advisor from MATH286, 426. 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: CPTR125

Minor in Mathematics Education—20
MATH145, 167, 182, 215, 220, 355; STAT285. This minor is available only to those obtaining elementary teacher certification. The regular minor listed above will also suffice for elementary certification.

Minor in Mathematics of Economics and Finance—20
MATH141, 142, 215, 286, STAT285. 340. This minor is available only to students obtaining a degree in the School of Business.

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. 109.

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. MATH141, 182 (Calculus I, Calculus with Applications)
2. MATH145, 166, 168 (Reasoning with Functions, Precalculus Algebra, Precalculus)

Minimum grade for prerequisites, except for MATH141, is C-.

Mathematics Placement Examination (MPE). See p. 36 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 Programs

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. 154.

Endorsement: Middle School Mathematics
The Department of Mathematics collaborates with the School of Education and the Berrien County Intermediate School District to administer the Alternative Certification Experimental Program (Math Endorsement Program) for Middle School Educators. Applications to this Program are initially screened by the School of Education and the Department of Mathematics, and then go through the regular Andrews admissions process. Courses are listed below under "Mathematics Education." Inquiries should be directed to Larry Burton (269) 471-3465, burton@andrews.edu; Lynelle Weldon (269) 471-3866, weldon@andrews.edu; or Judy Wheeler (269) 471-7725 ext. 302, jwheele@remc11.k12.mi.us.

Courses
See inside front cover for symbol code.

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
Arithmetic and Algebra Review I
Individualized review of arithmetic and algebra skills. Provides computer-generated drill problems, instant scoring and explanation, with conceptual instruction as required. Students completing the sequence requirements while enrolled in MATH091 are not required to take MATH092. Fall, Spring

MATH092
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. Prerequisite: Math 091. Fall, Spring

Undergraduate Courses

MATH141
Calculus I
MATH141, 142 is a standard introduction to single-variable calculus. MATH141 includes limits, continuity, derivatives, applications, and integration up through substitution. 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

MATH142
\textit{Calculus II}
Continuation of MATH141. Riemann sums, Riemann integral, Fundamental Theorem of Calculus, techniques of integration, improper integrals, applications, sequences, series, and tests of convergence. Prerequisite: MATH141. Fall, Spring

MATH145
\textit{Reasoning with Functions}
Logic, sets; functions given by tables, formulas, graphs; inverse functions; linear, quadratic, exponential and trigonometric 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

MATH165
\textit{College Algebra}
AU/GU 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
\textit{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
\textit{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

MATH168
\textit{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

MATH168 Alt (4)
\textit{Precalculus}
AU/GU course—see content above. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE \geq P2.

MATH182 Alt (3)
\textit{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 preferred; MATH145 is acceptable. Spring

MATH215
\textit{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. Prerequisite: MATH182 or 141. Fall

MATH220 Alt (3)
\textit{Geometry and Numbers}
Euclidean geometry and number systems for elementary and middle school teachers. Topics include proofs, algorithms, and historical development. Prerequisite: MATH145. Fall

MATH240
\textit{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: MATH142. Fall

MATH286
\textit{Differential Equations}
Elementary differential equations, first order equations, higher order linear equations, systems. Prerequisite: MATH142. Spring

MATH315 Alt (3)
\textit{Linear Algebra}
Vector spaces, eigenspaces, linear transformations, orthogonality, inner product spaces, quadratic forms, and selected topics. Prerequisites: MATH215, 355. Spring

MATH355
\textit{Discrete Mathematics}
Selected topics in discrete mathematics, including logic, set theory, relations, functions, algebraic structures and graph theory. Prerequisites: MATH141 or 182. Spring

MATH389
\textit{Mathematics Colloquium}
Participation in at least 10 mathematics colloquia or approved colloquia of other departments. Grade is based on attendance and notes taken at the colloquium. Repeatable to 2 credits. S/U. Fall, Spring

MATH405 Alt (3)
\textit{Applied Mathematics}
Solutions of first and second order partial differential equations, and applications. Prerequisites: MATH240, 286. Fall

MATH408 Alt (3)
\textit{Complex Analysis}
Elementary complex analysis, contour integrals, complex series. Prerequisites: MATH240 and 355. Spring

MATH426 Alt (3)
\textit{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: MATH141. Fall
MATHEMATICS 153

MATH431, 432 Advanced Calculus
Theorems on continuity, differentiation, integration, and convergence; additional selected topics such as topology, differentiable manifolds, and real analysis. Prerequisites: MATH240 and 355. Fall/Spring sequence

MATH441 Algebra
Study of groups, rings, fields, modules, vector spaces, and algebras. Prerequisites: MATH240 and 355.

MATH442 Algebra
Continuation of MATH441. Prerequisite: MATH441.

MATH475 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

MATH487 Special Topics in __________
Consult the instructor in regard to the topic to be covered. Prerequisite: Consent of teacher. Repeatable in different areas.

MATH495 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 four 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.

Statistics

STAT285 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

STAT285 Elementary Statistics
AU/GU course—see content above. Prerequisite: MPE ≥ P2.

STAT340 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: MATH141 or MATH142. Spring

Honors

MATH271-50 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: MATH142 and consent of instructor.

Graduate Courses

MATH530 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 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 the Berrien County Intermediate School District 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
Judy Wheeler (269) 471-7725, ext.302, jwheele@remc11.k12.mi.us

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 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
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
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
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
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
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.

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 (FORTRAN or C++) or CPTR151; MATH141, 142, 240, 286; and two out of three year-long