

**GRMN505**

(5)

**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.

**INLS575**

(1-3)

**Topics in \_\_\_\_\_**

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

**INLS590**

(1-3)

**Directed Study/Reading/Research/Project**

Studies in the area of French/Spanish language, literature, or civilization, as determined in consultation with the instructor.

**MATHEMATICS**

Haughey Hall, Room 121  
269-471-3423

[math@andrews.edu](mailto:math@andrews.edu)  
[www.math.andrews.edu](http://www.math.andrews.edu)

**Faculty**

Robert C. Moore, *Chair*  
Gina D. Creek  
Shandelle M. Henson  
Joon Hyuk Kang  
Yun Myung Oh  
Lynelle M. Weldon

**Mathematics & Science Center Faculty**

Keith G. Calkins, *Mathematics Coordinator*  
Gina D. Creek

**Emeriti**

Kenneth L. Franz  
Theodore R. Hatcher  
Donald H. Rhoads  
Edward J. Specht

Academic Programs	Credits
BS: Mathematics	39
Applied Mathematics	
Preparation for Secondary School Mathematics Teaching	
Preparation for Graduate Study in Mathematics	
BS: Mathematics Education	30
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)

MATH141, 142, 215, 240, 286, 355; MATH 315 or 441; STAT340 and at least 12 credits in additional courses chosen in consultation with a Mathematics Department advisor from MATH271, 315, 389, 405, 408, 426, 431, 432, 441, 442, 475, 487, 495, CPTR436. Students in a teacher certification program are required to take MATH475 and STAT285. (Note that STAT285 does not count toward the 39 major credits.) 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, STAT285, 340. (Note that STAT285 does not count toward the 20 minor credits.)

### 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 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. 121.

## 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. 39 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. 171.

### 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](mailto:burton@andrews.edu); Lynelle Weldon 269-471-3866, [weldon@andrews.edu](mailto:weldon@andrews.edu); or Judy Wheeler 269-471-7725 ext. 302, [jwheele@remc11.k12.mi.us](mailto:jwheele@remc11.k12.mi.us).

### Courses (Credits)

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 (3)

#### 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 (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. Prerequisite: Math 091. *Fall, Spring*

**Undergraduate Courses****MATH141 (4)*****Calculus I***

MATH141, 142 is a standard introduction to single-variable calculus. MATH141 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*

**MATH142 (4)*****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 (3)*****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 V (3)*****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 (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*

**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*

**MATH168 V (4)*****Precalculus***

AU/GU 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. *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. Prerequisite: MATH182 or 141. *Fall*

**MATH220 Alt (3)*****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 (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: MATH142. *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: MATH142. *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*

**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. Prerequisites: MATH141 or 182. *Spring*

**MATH389** (0.5)  
**Mathematics Colloquium**  
 Participation in at least 10 mathematics colloquia or approved colloquia of other departments. Grade is based on attendance, notes taken at the colloquia, and a project. Repeatable to 2 credits. S/U. Prerequisite: MATH141. *Fall, Spring*

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

**MATH408** ◆ Alt (3)  
**Complex Analysis**  
 Elementary complex analysis, contour integrals, complex series. Prerequisites: MATH240 and 355. *Spring*

**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: MATH141. *Fall*

**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 and 355. *Fall/Spring sequence*

**MATH441, 442** ◆ Alt (3)  
**Abstract Algebra**  
 Study of groups, rings, fields, modules, vector spaces, and algebras. Prerequisites: MATH240 and 355.

**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*

**MATH487** Alt (1-3)  
**Special Topics in \_\_\_\_\_**  
 Consult the instructor in regard to the topic to be covered. Prerequisite: Consent of 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.

**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*

**STAT285** V (4)  
**Elementary Statistics**  
 AU/GU 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: MATH141. *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: MATH142 and consent of 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 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](mailto:burton@andrews.edu)  
 Lynelle Weldon 269-471-3866, [weldon@andrews.edu](mailto:weldon@andrews.edu)  
 Judy Wheeler 269-471-7725, ext.302, [jwheele@remc11.k12.mi.us](mailto: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 (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.