GRADUATE COURSES

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

FREN505 **(5)**
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.

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

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(269) 471-3423
math@andrews.edu
http://www.math.andrews.edu

Faculty
Robert C. Moore, *Chair*
Shandelle M. Henson
Ronald D. Johnson
Joon Hyuk Kang
Lynelle M. Weldon

Lecturers
Keith G. Calkins
Shirleen Luttrell

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

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

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.
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. 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. Cognate Course: CPTR125.

Minor in Mathematics Education—20

(pending Michigan Department of Education approval)
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. 108.

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. 151.

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   (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
Real functions and relations, differentiation and applications. Introduction to integration. 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 Calculus I; integration of functions with applications; convergence of series. 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 ≥ P2. *Fall, Spring*

MATH165 **V (3)**
College Algebra
AU/HSI 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 ≥ P2.

MATH166 **(3)**
Precalculus Algebra
Equations and inequalities; algebraic, logarithmic, exponential, polynomial and rational functions, complex numbers; and selected topics. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE ≥ P2. *Fall, Spring*

MATH167 **Alt (2)**
Precalculus Trigonometry
Trigonometric functions and identities, vectors, and selected topics. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE ≥ P3 or MATH166 or MATH145. *Fall*

MATH168 **(4)**
Precalculus
Covers most of the content of MATH166 and MATH167. A study of equations and inequalities; algebraic, logarithmic, exponential, polynomial and rational functions; trigonometric functions and identities, vectors. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE ≥ P2. *Fall, Spring*

MATH168 **V (4)**
Precalculus
AU-HSI course—see content above. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE ≥ P2.

MATH182 **Alt (3)**
Calculus with Applications
Introduction to calculus of functions of one variable, including finding maxima and minima; partial derivatives; applications to problems in business and the social sciences. Fulfills the General Education Mathematics reasoning requirement. Prerequisite: MPE ≥ P4 or MATH166, 167 or 168 preferred; MATH145 is acceptable. *Spring*

MATH215 **(3)**
Introduction to Linear Algebra
Vectors, matrices, determinants, and eigenvalues, 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
Curves and surfaces, partial derivatives, multivariable calculus; multiple integrals, line and surface integrals; Stokes', Green's and divergence theorems. Prerequisite: MATH142. *Fall*

MATH286 **(3)**
Differential Equations
Elementary differential equations, first order equations, higher order linear equations, systems. Prerequisite: MATH142. *Spring*

MATH315 **Alt (3)**
Linear Algebra
Vector spaces, linear transformations, bilinear and quadratic forms. Prerequisites: MATH215 and 355. *Spring*

MATH355 **(3)**
Discrete Mathematics
Selected topics in discrete mathematics, including logic, set theory, relations, functions, algebraic structures and graph theory. 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 and notes taken at the colloquium. Repeatable to 2 credits. S/U. *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 **♦ Alt (3)**
Algebra
Study of groups, rings, fields, modules, vector spaces, and algebras. Prerequisites: MATH240 and 355.

MATH442 **♦ Alt (3)**
Algebra
Continuation of MATH441. Prerequisite: MATH441.

MATH475 ♦ **Alt (3)**
Geometry
Axiomatic development of Euclidean, non-Euclidean, affine, and projective spaces. 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 teacher. 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 four hours of study per week is expected for each credit. Grades are assigned on the basis of a 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/HSI 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 or 182. *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

MAED505 through MAED625 are available only to participants in the Alternative Certification Experimental Program (Math Endorsement Program) for Middle School Educators. For details on this program see "Endorsement: Middle School Mathematics" on p. 148. These courses are taught as funding is available, in rotation, during the regular school year and during the summer, according to a schedule set by the Administrative Committee for the Program.

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 AND SCIENCE

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Faculty

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Gordon J. Atkins, Biology
Bill Chobotar, Biology
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James L. Hayward, Biology
Shandelle M. Henson, Mathematics
Ronald D. Johnson, Mathematics
Joon Hyuk Kang, Mathematics
Mickey D. Kutzner, Physics
Robert E. Kingman, Physics
Margarita C. K. Mattingly, Physics
David N. Mbungu, Biology
Getahun Merga, Chemistry
Robert C. Moore, Mathematics
Desmond H. Murray, Chemistry
Marlene N. Murray, Biology
G. William Mutch, Chemistry
D. David Nowack, Chemistry
S. Clark Rowland, Physics
David E. Steen, Biology
John F. Stout, Biology
Stephen C. Thorman, Physics, Computer Science
Lynelle M. Weldon, Mathematics
Dennis W. Woodland, Biology
Peter A. Wong, Chemistry
Robert E. Zdor, Biology

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.

SPECIFIC ADMISSION REQUIREMENTS

1. Students admitted into the MS: Mathematics and Science program must hold a baccalaureate degree with a major in one of the above areas with a cumulative GPA of at least 2.60 (4.00 system) and have 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 laboratory science courses: BIOL165, 166, CHEM131, 132 and PHYS241, 242, 271, 272. A student may be admitted with deficiencies in the above courses, but this