MATHEMATICS

Mathematics is one of the most precise and versatile human languages.

With it, mathematical scientists have described and understood complex physical phenomena, supported the infrastructure of the internet era, optimized production in industrial processes, and cultivated the creativity of young minds. As a language, together with its axiomatic underpinnings, mathematics is also a much-explored structure in itself. In recent decades, the boundary between pure and applied mathematics has dissolved, and training in both is important for every mathematician. The 21st century, with its growing importance of big data and computation, offers many opportunities to mathematicians.

The Department of Mathematics and Statistics offers B.A. and B.S. degrees in Mathematics, Applied Statistics, and Actuarial Mathematics. Additionally, minors are available in Mathematics, Applied Statistics, and Computer and Computational Mathematics. Courses in Mathematics Education are also offered..

Mathematics and Applied and Computational Mathematics 4+1 Option

The Accelerated Masters Studies Option (4+1 Option) in Mathematics and Applied and Computational Mathematics (MATH-ACM) is designed to allow motivated students to earn both a B.A. or B.S. in Mathematics and an M.S. in Applied and Computational Mathematics with one additional year of coursework. This is achieved by a double-counting allowance of up to 16 credits at the graduate level (500-level or above) towards the undergraduate and graduate degrees. At least one additional year of graduate work would be needed to complete the rest of the requirements of the Master's program, enabling students to earn two degrees in a total of five years.

Eligibility

In order to be eligible for this program, a student must:

- Be a declared mathematics major with at least 60 completed credit hours.
- Have completed the prerequisite courses for the math major and Math 300. Math 227 and Math 228 must be with grades of B+ or better.
- Have a cumulative GPA of at least 3.2.

How to Apply

Complete the graduate online application (https://umdearborn.edu/admissions-aid/graduate-admissions/how-apply/) for Applied and Computational Mathematics (MS) and select "yes" to the 4+1 option in the Academic Plan section.

Students applying through the 4+1 option are required to submit 2 letters of recommendation, both from faculty in mathematics or statistics.

MATH-ACM Courses

The courses double counted must be elected at the 500 level and include:

- Math 551 (Advanced Calculus)
- Math 562 (Mathematical Modeling)
- Math 572 (Introduction to Computational Mathematics)

This satisfies the major requirement for MATH 451 and the two electives for the A.B. or B.S. in mathematics.

- One course from MATH 554 and MATH 555 and one course from STAT 530, 531, 540, and 560 or two courses from STAT 530, 531, 540, and 560.

  This satisfies the Core Elective requirement and a part of the Cognate requirement for the major, or the complete Cognate requirement for the major.

The M.S. degree is completed by selecting 2 more ACM electives, two master's level cognates, and completing a Masters Project.

- ***A student may not receive credit for both a 400 and 500 level equivalent courses (for example, both Math 455 and Math 555).***

Dearborn Discovery Core (General Education)

All students must satisfy the University's Dearborn Discovery Core requirements (https://catalog.umd.umich.edu/undergraduate/gen_ed_ddc/), in addition to the requirements for the major. Students must also complete all CASL Degree Requirements. (https://catalog.umd.umich.edu/undergraduate/college-arts-sciences-letters/)

Prerequisites to the Major

Students desiring to major in mathematics are required to have successfully completed:

Code	Title	Credit Hours
MATH 115	Calculus I	4
MATH 116	Calculus II	4
MATH 215	Calculus III	4
MATH 227	Introduction to Linear Algebra	3
MATH 228	Diff Eqns with Linear Algebra	4
Select one of the following:		2-4
CIS/CCM 150	Computer Science I	
CIS 1501	CS I for Data Scientists	
STAT 327	Statistical Computing	
ENGR 216	Computer Meth for Engineers	
Total Credit Hours		**21-23**

Major Requirements

A total of at least 32 credit hours of coursework must be elected in the major and cognate areas at the upper level (300-400 level courses). Students are required to elect at least 27 hours of coursework in the mathematics major including:

Code	Title	Credit Hours
Required Courses		**11**
MATH 300	Math Lang Proof & Struct	
MATH 412	Introduction to Modern Algebra	

MATH 451	Advanced Calculus	
Probability/Statistics -Select one of the following:		**3-4**
MATH 325	Probability	
STAT 325	Applied Statistics I	
STAT 327	Statistical Computing	
Core Elective - Select one of the following:		**3**
MATH 331	Survey of Geometry	
MATH 395	Elementary Number Theory	
MATH 454	Fourier Series and Boundary Value Problems	
MATH 455	Functions of a Complex Variable with Applications	
Capstone - Select one of the following:		**4**
MATH 492	Introduction to Topology	
MATH 4000	Capstone in Mathematics	
Electives - Select two courses from the following:		**6**
MATH 325	Probability	
MATH 331	Survey of Geometry	
MATH 390	Topics in Mathematics	
MATH 395	Elementary Number Theory	
MATH 396	Introduction to Cryptography	
MATH 420	Stochastic Processes	
MATH 423	Applied Linear Algebra	
MATH 425	Statistical Inference	
MATH 454	Fourier Series and Boundary Value Problems	
MATH 455	Functions of a Complex Variable with Applications	
MATH 458	Introduction to Wavelets	
MATH 462	Mathematical Modeling	
MATH 472	Introduction to Computational Mathematics	
Cognates		**6-7**
Select 6-7 credits upper level (300/400 and 3000/4000) from the following:		
CCM		
CHEM (including CHEM 225 and CHEM 226) [1]		
CIS (including CIS 200 and CIS 290) [1]		
ECE		
ECON 305	Economic Statistics	
ECON 4015	Introduction to Econometrics	
IMSE (except IMSE 334) [3]		
ME		
PHIL 350	Symbolic Logic [2]	
PHIL/STS 485	Philosophy of Science	
PHYS		
STAT (Excuding STAT 455; Only one of STAT 301, STAT 325 can be used to satisfy this requirement) [3]		
Total Credit Hours		**33-35**

[1] Courses joined with **"and"** count together as **one course.**

[2] Cannot receive credit for both PHIL 234 and PHIL 350. PHIL 234 cannot be used in Cognates.

[3] Cannot receive credit for both Stat 325 and IMSE 317.

Notes:

1. Courses listed in more than one place can only count toward one of the requirements. For example, a student who elects Stat 325 in the probability/statistics requirement must elect another course for a cognate. A student who elects Math 455 in the core elective, must elect another course in the electives.
2. STAT 301 cannot be used in place of STAT 325 in the probability/statistics requirement in the major.
3. Students who wish to use graduate-level courses, numbered 500 or higher, as part of the 27 credit hours of upper-level MATH coursework required for the major, must submit a Petition to obtain the approval of the faculty Program Advisor in Mathematics.
4. Students seeking secondary teacher certification must take MATH 331, MATH 486, EDD 450 and EDD 451. Also, MATH 395 and a course in statistics (STAT) are recommended for such students. None of the following MATH courses may be used to fulfill any requirements of either a Mathematics major or a Mathematics minor: MATH 381, MATH 382, MATH 383 , MATH 384, MATH 385, MATH 386, MA

5. Applied Statistics courses (STAT) cannot be used to fulfill the Math minor/concentration requirements.

6. At least 12 of the 27 upper level credit hours in the mathematics major must be elected at UM-Dearborn in order to graduate.

7. In order to enroll in a mathematics class, a student must have earned a grade of at least C- in all prerequisite mathematics courses; a grade below C- signals that the student should *immediately repeat* the class in order to build a stronger foundation for subsequent study. The same principle applies when a mathematics course is a prerequisite for courses of other disciplines.

8. Students admitted to the 4+1 Option may substitute a maximum of 16 credits from the following: MATH 520 for MATH 420, MATH 523 for MATH 423, MATH 525 for MATH 425, MATH 551 for MATH 451, MATH 554 for MATH 454, MATH 555 for MATH 455, MATH 562 for MATH 462, MATH 572 for MATH 472, STAT 530 for STAT 430, STAT 531 for STAT 431, STAT 540 for STAT 440 or STAT 560 for STAT 460.

Credit by Examination

The department grants credit for Calculus I to those students who have received a score of three, four, or five on the AB Exam or a score of three on the BC Exam of the Advanced Placement Program Tests of the College Entrance Examination Board. Credit is granted for both Calculus I and Calculus II to those students who have received a score of four or five on the BC Exam of the Advanced Placement Program Tests. In each case, the student is then eligible to elect the next calculus course in the calculus sequence.

Minor or Integrative Studies Concentration Requirements

A minor or concentration consists of 12 credit hours in mathematics (MATH) courses approved for upper-level credit in the mathematics major . (Excluding MATH 385, 386, 387, 391, 442, 443, 444, 445, 446, 447, 449, 486).

- A minimum GPA of 2.0 is required for the minor/concentration. The GPA is based on all coursework required within the minor (excluding prerequisites).
- The use of transfer credit, field placements, internships, seminars, S/E graded courses, and independent study/research courses is limited to 3 credits in a 12 credit hour minor/concentration and 6 credits in a 15 credit hour and above minor/concentration.

- Courses within a minor/concentration cannot be taken as Pass/Fail (P/F).
- Minors requiring 12 credits may share one course with a major. Minors requiring 15 credits or more may share two courses with a major. This does not apply to concentrations for the Integrative Studies major.

Learning Goals

The Department of Mathematics and Statistics provides students majoring in mathematics a broad exposure to the interconnecting, powerful, and creative nature of mathematics. While developing content specific knowledge, students grow in persistence and analytical ability in an educationally supportive and inclusive environment.

1. Communication: Students acquire broad and effective mathematical communication skills including the ability to state problems carefully, articulate assumptions, and understand the importance of precise definition, read mathematics with understanding, and communicate ideas clearly and coherently both verbally and in writing.
2. Problem Solving: Students are able to solve mathematical problems flexibly, accurately and efficiently including the ability to recognize patterns and make generalizations, assess the correctness of solutions, create and explore examples, devise and test conjectures, and use technology effectively, when appropriate.
3. Reasoning: Students are able to rigorously employ logical reasoning including the ability to recognize and make mathematically rigorous arguments.
4. Connections: Students are able to connect concepts within and across mathematical disciplines including the ability to link applications to theory.
5. Independence: Students develop mathematical independence and experience open ended inquiry.

MATH 080 Introductory Algebra 3 Credit Hours
The Developmental Mathematics sequence (MATH 080, MATH 090) is offered as a service to students who need extra preparation in mathematics. MATH 080 is for students who are likely to need two semesters of additional preparation in mathematical computation and symbol manipulation, communication, and conceptual understanding. Topics in the two-course sequence include: arithmetic readiness, real numbers and expressions, linear equations and inequalities, lines and functions, systems of linear equations, rational expressions and equations, radicals and complex numbers, quadratic equations and functions, function operations and inverses. Students are required to have Internet-ready devices available for each class meeting. Skill development takes place online and outside scheduled class meetings. The course is graded on an A, B, C, NC (not completed) basis. This course is offered for additive credit.
Prerequisite(s): Math Placement with a score of 080

MATH 090 Intermediate Algebra 3 Credit Hours
The Developmental Mathematics sequence (MATH 080, MATH 090) is offered as a service to students who need extra preparation in mathematics. MATH 090 is for students who (1) have successfully completed MATH 080 or (2) are likely to require only one semester of additional preparation in mathematical computation and symbol manipulation, communication, and conceptual understanding. Topics in the two-course sequence include: arithmetic readiness, real numbers and expressions, linear equations and inequalities, lines and functions, systems of linear equations, rational expressions and equations, radicals and complex numbers, quadratic equations and functions, function operations and inverses. Students are required to have Internet-ready devices available for each class meeting. Skill development takes place online and outside scheduled class meetings. The course is graded on an A, B, C, NC (not completed) basis. This course is offered for additive credit. (F, W).
Prerequisite(s): MATH 080 or Math Placement with a score of 090

MATH 100 College Algebra for Calculus 4 Credit Hours
College Algebra for Calculus (Math 100) is a semester-long course designed for students who plan on pursuing further science, technology, engineering, and mathematics (STEM) coursework that requires a thorough knowledge of functions and algebraic reasoning. This course is the first in a two-course sequence (together with Math 101) which prepares students for entry into Calculus I (Math 115). Math 100 gives students a strong foundation in functions and their behavior by using multiple representations and explicit covariational reasoning to investigate and explore quantities, their relationships, and how these relationships change. Additionally, this course provides students with the algebraic tools necessary to analyze a variety of function types including linear, quadratic, polynomial, and power functions. Students can receive credit for only one of MATH 100, MATH 1000, MATH 104, and MATH 1040. (F, W).
Prerequisite(s): MATH 080 or Math Placement with a score of 90 or Math Placement with a score of 100 or Math Placement with a score of 104 or Math Placement with a score of 105

MATH 1000 College Algebra for Calculus with Studio 4 Credit Hours
College Algebra for Calculus with Studio (Math 1000) is a semester-long course designed for students who plan on pursuing further science, technology, engineering, and mathematics (STEM) coursework that requires a thorough knowledge of functions and algebraic reasoning. This course is the first in a two-course sequence (together with Math 101) which prepares students for entry into Calculus I (Math 115). Math 1000 gives students a strong foundation in functions and their behavior by using multiple representations and explicit covariational reasoning to investigate and explore quantities, their relationships, and how these relationships change. Additionally, this course provides students with the algebraic tools necessary to analyze a variety of function types including linear, quadratic, polynomial, power, exponential, and logarithmic functions. This course must be elected together with Math 1001: College Algebra for Calculus Studio. Students can receive credit for only one of MATH 100, MATH 1000, MATH 104, and MATH 1040. (F, W).
Prerequisite(s): Math Placement with a score of 090 or MATH 080
Corequisite(s): MATH 1001
Restriction(s):
Cannot enroll if Level is

MATH 1001 College Algebra for Calculus Studio 1 Credit Hour
This course provides corequisite support for the companion class MATH 1000. By covering intermediate algebra and precalculus topics in a just-in-time format, students will be better positioned for success in their Math 1000 course. Topics include: number sense and basic operations, proportional reasoning, linear relationships and equations, exponential and radical expressions, quadratic equations, functions, systems of equations and inequalities, and transformations on graphs. Students who elect MATH 1001 should also elect MATH 1000. A math placement score of at least MATH 90 is required. (F, W).
Prerequisite(s): Math Placement with a score of 090 or MATH 080
Corequisite(s): MATH 1000

MATH 101 Trigonometry for Calculus 4 Credit Hours
Trigonometry for Calculus (Math 101) is a semester-long course designed for students who plan on pursuing further science, technology, engineering, and mathematics (STEM) coursework that requires a thorough knowledge of functions and algebraic reasoning. This course is the second in a two-course sequence (together with Math 100) which prepares students for entry into Calculus I (Math 115). Math 101 gives a strong foundation in functions and their behavior by using multiple representations and explicit covariational reasoning to investigate and explore quantities, their relationships, and how these relationships change. Students use their knowledge of functions to model and solve problems using exponential, logarithmic, and trigonometric functions and their properties. Students can receive credit for only one of MATH 101 and MATH 105. (F, W).
Prerequisite(s): MATH 100 or MATH 1000 or MATH 104 or MATH 1040

MATH 104 College Algebra 4 Credit Hours
Topics include equations and inequalities; linear, quadratic, polynomial, rational, logarithmic and exponential functions along with their graphs and applications; and systems of linear inequalities. This course does not cover trigonometric functions and cannot be used as a prerequisite for MATH 115. Students electing this course should have at least taken two years of High School Algebra and one year of High School Geometry or MATH 090. Students can receive credit for only one of MATH 100, MATH 1000, MATH 104, and MATH 1040. (F, W).
Prerequisite(s): MATH 090 or Math Placement with a score of 100 or Math Placement with a score of 104 or Math Placement with a score of 105

MATH 1040 College Algebra with Studio 4 Credit Hours
Topics include equations and inequalities; linear, quadratic, polynomial, rational, logarithmic and exponential functions along with their graphs and applications; and systems of linear inequalities. This course does not cover trigonometric functions and cannot be used as a prerequisite for MATH 115. Students electing this course should have at least taken two years of High School Algebra and one year of High School Geometry or MATH 090. This course must be elected together with Math 1041: College Algebra Studio. Students can receive credit for only one of MATH 100, MATH 1000, MATH 104, and MATH 1040. (F, W).
Prerequisite(s): MATH 080 or Math Placement with a score of 090
Corequisite(s): MATH 1041

MATH 1041 College Algebra Studio 1 Credit Hour
This course provides corequisite support for the companion class MATH 1040. By covering intermediate algebra topics in a just-in-time format, students will be better positioned for success in their Math 1040 course. Topics include: number sense and basic operations, proportional reasoning, exponential and radical expressions, functions, systems of equations, and transformations on graphs. Students who elect MATH 1041 should also elect MATH 1040. A math placement score of at least MATH 90 is required. (F, W).
Prerequisite(s): Math Placement with a score of 090
Corequisite(s): MATH 1040

MATH 105 Pre-Calculus 4 Credit Hours
The primary purpose of this course is to prepare students for success in Calculus. Topics include equations and inequalities, linear, quadratic, polynomial, rational, logarithmic, exponential and trigonometric functions along with their graphs, and application of these functions. Students electing this course should have taken at least two years of High School Algebra and one year of High School Geometry or MATH 090 with minimum grade of C-. (F,W,S) (F, W, S).
Prerequisite(s): MATH 090 or Math Placement with a score of 105

MATH 113 Calc I for Biology & Life Sci 4 Credit Hours
This course develops basic concepts of Calculus from the perspectives of Biology and Life Sciences. Topics include differential and integral calculus of algebraic/logarithmic/exponential functions of one variable, limits, continuity, differentiation, integration, graphing, optimization, related rates and area. Applications include modeling biological problems of medicine, genetics, Biomechanics, ecology, population growth and decay. This course does not fulfill the calculus requirements for concentration in chemistry, physics, biochemistry, engineering, or mathematics. A minimum grade of C- is required in the prerequisite. Student cannot receive credit for both Math 113 and Math 115.
Prerequisite(s): MATH 105 or MATH 104 or MATH 1040 or MATH 100 or MATH 1000 or Math Placement with a score of 115

MATH 114 Calc II for Biology & Life Sci 4 Credit Hours
The topics of this course include advanced methods of integration (integration by parts, partial fraction), modeling with differential equations, some elementary differential equations, matrix algebra, systems of linear equations using matrix method, introduction to probability, conditional probability, discrete and continuous random variables (exponential and normal random variables). Problems in biology, medicine and physiology are used to illustrate how computation and mathematics can improve and enhance the understanding of these problems. Students cannot receive credit for both Math 114 and Math 116. A minimum grade of C- is required in the prerequisite.
Prerequisite(s): MATH 113 or MATH 115

MATH 115 Calculus I 4 Credit Hours
Calculus is the study of change and accumulation in continuously variable quantities. This course covers limits and continuity, derivatives and their applications, and integrals, with algebraic, exponential, and trigonometric functions and their inverses. A minimum grade of C- is required in the prerequisite. Students cannot receive credit for both MATH 113 and MATH 115. (F, W, S).
Prerequisite(s): MATH 105 or (MATH 104 and MATH 1045) or (MATH 100 and MATH 1045) or (MATH 1000 and MATH 1045) or (MATH 104 and MATH 101) or (MATH 100 and MATH 101) or (MATH 1000 and MATH 101) or Math Placement with a score of 115

MATH 1151 Calculus I Studio 1 Credit Hour
This course provides corequisite support for the companion class MATH 115. By covering precalculus topics in a just-in-time format, students will be better positioned for success in their Math 115 course. Topics include: review of functions and their graphs, review of key algebra and trigonometry skills associated with calculus, and practice with key topics in calculus including limits, differentiation, and integration and their applications. Students who elect MATH 1151 should also elect MATH 115. (F, W).

MATH 116 Calculus II 4 Credit Hours
This course continues the study of Calculus from Math 115, including applications and techniques of integration, improper integrals, parametric equations, polar coordinates, and sequences and series, including Taylor series. A minimum grade of C- is required in the prerequisite. Students cannot receive credit for both MATH 114 and MATH 116. (F, W, S).
Prerequisite(s): MATH 115

MATH 131 Conceptual Mathematics 4 Credit Hours
The purpose of Math 131 is to develop an awareness of the use of mathematics in the world around us. Students are encouraged to understand organizational tools of mathematics, including set theory and the use of deductive logic. Areas of application may include: consumer Mathematics, Probability, Statistics, social decision making, apportionment, graph theory, and mathematical modeling. Students intending to elect this course should have taken the equivalent of one year of high school algebra and one year of high school geometry. This course is not open to mathematics concentrators. (F,W,S).

MATH 215 Calculus III 4 Credit Hours
Vectors in the plane and space, vector-valued functions and curves, functions of several variables including limits, continuity, partial differentiation and the chain rule, multiple integrals and coordinate transformations, integration in vector fields, and Green's and Stokes' theorems. A minimum grade of C- is required in the prerequisite course. (F, W, S).
Prerequisite(s): MATH 116

MATH 227 Introduction to Linear Algebra 3 Credit Hours
An introduction to the theory and methods of linear algebra with matrices. Topics include: systems of linear equations, algebra of matrices, matrix factorizations, vector spaces, linear transformations, eigenvalues and eigenvectors, science and engineering applications, and computational methods. A minimum grade of C- is required in the prerequisite. (F, W, S).
Prerequisite(s): MATH 116

MATH 228 Diff Eqns with Linear Algebra 4 Credit Hours
Full Title: Differential Equations with Linear Algebra This course provides an introduction to ordinary differential equations. Emphasis is placed on the development of abstract concepts and applications for first-order and linear higher-order differential equations, systems of differential equations, introductory numerical methods, matrix algebra, and Laplace transform techniques. It is recommended that students complete MATH 215 or MATH 205 before enrolling in this course. Students cannot receive credits for both MATH 228 and MATH 216 and MATH 217 (F, S, W).
Prerequisite(s): MATH 116

MATH 276 Discrete Math Meth Comptr Engr 4 Credit Hours
An introduction to fundamental concepts of discrete mathematics for computer engineering. Topics will be chosen from: set theory, partially ordered sets, lattices, Boolean algebra, semi-groups, rings, graphical representation of algebraic systems, graphs and directed graphs. Applications in various areas of computer engineering will be discussed. A minimum grade of C- is required in the prerequisite. (F, W, S).
Prerequisite(s): MATH 116

MATH 300 Math Lang Proof & Struct 3 Credit Hours
A required course for students completing a Mathematics concentration, this course is also a prerequisite for many upper-level Mathematics courses. The course focuses on developing the following: an understanding of, and facility with, the logic and syntax of mathematical statements; and ability to recognize and propose appropriate strategies and outlines for proving given statements; facility in writing mathematical proofs; a knowledge base/toolbox of foundational material including basic concepts and terminology related to naïve set theory.
Prerequisite(s): MATH 217 or MATH 227

MATH 325 Probability 3 Credit Hours
Brief overview of summary and display of data, probability concepts, discrete and continuous random variables and associated probability models, expectation, independent random variables, probability generating functions and moment generating functions, sampling distributions, the central limit theorem, the t-distribution, properties of estimators, and interval estimation. Previously taught as Mathematical Statistics I. (F).
Prerequisite(s): MATH 114 or MATH 116

MATH 331 Survey of Geometry 3 Credit Hours
A development of Euclidean geometry as a formal axiom system and an introduction to non-Euclidean geometries and to Transformational Geometry. Geometric models and the history of geometry are stressed. Development of students' geometric intuition as well as their ability to work in a formal axiom system are emphasized. (F).
Prerequisite(s): MATH 116 and (MATH 200 or MATH 300)

MATH 335 Mathematical Interest Theory 4 Credit Hours
This introductory course is designed to lay the foundation for understanding the mathematical theory of interest, emphasizing both theoretical underpinnings and practical applications. Designed for students pursuing careers in finance, actuarial science, and economics, the course covers essential topics, including interest rates, annuities, bonds, and loans. Students will not only learn the theoretical aspects of these financial instruments but will also gain hands-on experience in calculating their values. Advanced topics such as duration and portfolio immunization, among others, will also be explored. (F, AY).
Prerequisite(s): MATH 116

MATH 381 Mathematics for Elementary Teachers 1: Attribution, Geometry, and Measurement 3 Credit Hours
This inquiry-based laboratory course intends to support the learning of elementary educators (birth to grade 6) in foundations of attribute concepts; including sorting, comparing, and representing 2D and 3D objects; early geometry concepts; and measurement. The course integrates these areas of mathematical content with pedagogy, including creating mathematical learning environments, selecting worthwhile mathematical tasks, attending to and reacting to others' mathematical thinking, and supporting caregivers in fostering their child's success in mathematics. (W, YR).

MATH 382 Mathematics for Elementary Teachers 2: Early Number Concepts 3 Credit Hours
This inquiry-based laboratory course intends to support the learning of early childhood educators (birth to grade 3) in foundations of number concepts; including counting, quantity comparison, number systems and place value, and early fraction concepts. The course integrates these areas of mathematical content with pedagogy, including creating mathematical learning environments, selecting worthwhile mathematical tasks, attending and reacting to others' mathematical thinking, and supporting caregivers in fostering their child's success in mathematics. (F, YR).

MATH 383 Mathematics for Teachers III: Whole Numbers and Operations 3 Credit Hours
This course is designed to provide future teachers with opportunities to develop the mathematical understandings crucial to the teaching of whole numbers and operations concepts in the elementary grades. The students will study mathematical ideas including composing and decomposing whole numbers, different meanings and representations for operations, reasoning behind multiple solution strategies and representations, and connections among those solutions and representations. The course integrates mathematical content with pedagogy, including creating inclusive mathematical learning environments, selecting worthwhile mathematical tasks, attending and reacting to others' mathematical thinking, and supporting caregivers in fostering their child's success in mathematics. (F).

MATH 384 Mathematics for Teachers IV: Fractions and Operations 3 Credit Hours
This course is designed to provide future teachers with opportunities to develop the mathematical understandings crucial to the teaching of fractions and operations concepts in the elementary grades. The students will study mathematical ideas including composing, decomposing, and renaming fractions and decimals, different meanings and representations for fractions and decimals, reasoning behind multiple solution strategies and representations for fraction computation problems, connections among those solutions and representations, and developing solution strategies for solving proportional situations. The course integrates mathematical content with pedagogy, including creating inclusive mathematical learning environments, selecting worthwhile mathematical tasks, attending and reacting to others' mathematical thinking, and supporting caregivers in fostering their child's success in mathematics. (W).
Prerequisite(s): MATH 383

MATH 387 Math for Middle Grade Teachers 3 Credit Hours
The purpose of this course is to provide future middle grades mathematics teachers with foundational knowledge of mathematics they will teach. An inquiry approach is emphasized involving problem solving, problem posing, pattern seeking, reasoning, justification, representations, and communications. Topics in Math 387 include data analysis; probability; the geometry of three-dimensions including shape, spatial visualization, and measurement; geometric concepts of similarity and congruence; coordinate geometry; and transformational geometry. Algebraic reasoning is integrated throughout. (OC).
Prerequisite(s): MATH 384
Restriction(s):
Can enroll if College is Education, Health, and Human Services

MATH 390 Topics in Mathematics 1 to 3 Credit Hours
A course designed to offer selected topics in different areas of mathematics. The specific topic or topics will be announced together with the prerequisites each term. Course may be repeated for credit when specific topics differ.

MATH 390E Topics in Mathematics 3 Credit Hours
TOPIC TITLE: Preparation for Industrial Careers PIC Math prepares mathematical science students for industrial careers by engaging them in research problems that come directly from industry. A strong component of PIC Math involves students working as a group on a semester-long undergraduate research problem from business, industry, or government. Undergraduate research is a high impact teaching and learning practice and has been shown to improve students abilities in Problem solving. Critical thinking, Independent thinking, and Communicating.
Prerequisite(s): MATH 200 or MATH 205 or MATH 215 or MATH 216 or MATH 217 or MATH 227 or MATH 276

MATH 391 Topics in Mathematics Edu 1 to 3 Credit Hours
A course designed to offer selected topics in mathematics related to K-12 education. The specific topic or topics will be announced together with the prerequisites each term. Course may be repeated for credit when specific topics differ. (OC).

MATH 395 Elementary Number Theory 3 Credit Hours
Properties of the integers, the division algorithm, Euclid's algorithm, Fermat's theorems, unique factorization of integers into primes, congruences, arithmetic functions, Diophantine equations, continued fractions, quadratic reciprocity. A minimum grade of C- is required in the prerequisite. (F).
Prerequisite(s): MATH 215 or MATH 227 or MATH 228 or MATH 276

MATH 396 Introduction to Cryptography 3 Credit Hours
This course discusses ways of encrypting information, a function which is vital to economics, defense and the empowerment of society. It is more crucial now than ever before to be able to securely transfer information in this age of electronic communication. After discussing primitive ways of encrypting information and explaining the need for more sophisticated encoding methods, this course explores the mathematics (number theory, finite fields and probability) behind both historic and more recent cryptosystems that have been developed for the secure transmission of data along non secure channels. This course continues with symmetric and public key cryptosystems, elliptic curves, digital signatures, zero knowledge protocols and other more advanced methods. This course does not assume any prior knowledge of number theory or probability. A minimum grade of C- is required in the prerequisite. (W).
Prerequisite(s): MATH 215 or MATH 227 or MATH 228 or MATH 276

MATH 399 Independent Studies in Math 1 to 4 Credit Hours
Independent study in mathematics for topics at the junior level. Topics and objectives chosen by agreement between student and instructor.

MATH 4000 Capstone in Mathematics 4 Credit Hours
Math 4000 is the Capstone course in Mathematics, covering an advanced topic in Mathematics determined by the instructor. Topics may include, but are not limited to, algebraic geometry, functional analysis, functions of several complex variables, numerical analysis, partial or ordinary differential equations, combinatorics, probability, number theory, or topology. Students are expected to complete a research project in the area of the particular topic. A minimum grade of C- is required in the prerequisite. (W).
Prerequisite(s): MATH 300
Restriction(s):
Can enroll if Class is Junior or Senior

MATH 404 Dynamical Systems 3 Credit Hours
This course is an introduction to nonlinear dynamics and chaos with applications taken from engineering and the sciences. Topics include: one dimensional flows and bifurcations, two dimensional linear systems, phase plane analysis, limit cycles, and bifurcations. The class will finish with an introduction to chaotic systems and, if time permits, a study of fractals and strange attractors. A minimum grade of C- is required in the prerequisite. Students cannot receive credit for both MATH 404 and MATH 504. (OC).
Prerequisite(s): MATH 228

MATH 412 Introduction to Modern Algebra 4 Credit Hours
This course covers an introduction to group theory, ring theory and field theory. Topics in group theory include subgroups, group homomorphisms, factor groups, isomorphism theorems, simple groups, cyclic groups, dihedral groups and permutation groups. Topics in ring theory include ideals, integral domains, Euclidean domains, principal ideal domains, unique factorization domains, and modules. Topics in field theory include field extensions, Kronecker's theorem, and Galois Theory. Students cannot receive credit for both MATH 412 and MATH 512. (W).
Prerequisite(s): MATH 300 and MATH 227

MATH 413 Linear Algebra 3 Credit Hours
Vector spaces, linear transformations and matrices, determinants, inner product spaces, bilinear and quadratic forms, Hamilton-Cayley theorem, eigenvalues and eigenvectors, and spectral theorem. Students cannot receive credit for both MATH 413 and MATH 513. (F)
Prerequisite(s): MATH 300 and (MATH 217 or MATH 227)

MATH 420 Stochastic Processes 3 Credit Hours
Review of distribution theory. Introduction to stochastic processes, Markov chains and Markov processes, counting, and Poisson and Gaussian processes. A grade of C- or better is required in the prerequisite. Students cannot receive credit for both MATH 420 and MATH 520. (OC).
Prerequisite(s): MATH 325 or STAT 325 or IMSE 317 or ME 364

MATH 423 Applied Linear Algebra 3 Credit Hours
Review of elementary linear algebra concepts followed by the study of Gaussian elimination and solutions of systems of equations, matrix factorizations, inverses, vector spaces and subspaces, linear transformations, determinants, eigenspaces and eigen analysis, singular value decomposition. Applications may include discrete Fourier analysis, optimization, solutions of systems of differential equations and data science. Students cannot receive credit for both MATH 423 and MATH 523. (AY).
Prerequisite(s): MATH 228 and MATH 227

MATH 425 Statistical Inference 3 Credit Hours
Statistical inference applies probability theory to draw conclusions about a population when given information only from a sample. Students will learn and apply inferential procedures derived within a rigorous mathematical framework. In this course the fundamentals of mathematical statistics are studied, building on knowledge of probability theory. This course will cover point estimators (method of moments, maximum likelihood, Bayesian), confidence intervals, hypothesis testing, regression, and some theory, such as sufficient statistics and the likelihood ratio test. Probability theory will be reviewed as needed, and a statistical software such as RStudio will be introduced and used. If time allows, further topics will be considered, such as simulation and nonparametric methods. After taking this course, students will possess a deep understanding of how statistics works under the hood and in the real world. A minimum grade of C- is required in the prerequisite. Students cannot receive credit for both MATH 425 and MATH 525. (W).
Prerequisite(s): MATH 325 or STAT 325 or IMSE 317 or ME 364

MATH 435 Mathematics of Finance 3 Credit Hours
Full Course Title: Introduction to Mathematics of Finance This introductory course is designed for students aiming to pursue careers in finance, actuarial science, and economics. It focuses on the fundamentals of options pricing and risk management, exploring the use and valuation of various types of options, including call and put options. Students will learn how these options can be employed alongside underlying assets for risk management purposes. The course covers key pricing models, such as binomial trees and the Black-Scholes Formula, to approximate and determine the prices of European and American call and put options. If time allows, the course will also delve into the significance of Option Greeks, optimal portfolio theory, and other risk management strategies for creating hedged asset portfolios. (OC).
Prerequisite(s): MATH 325

MATH 442 Geometry for Teachers 3 Credit Hours
Properties of two and three-dimensional figures are covered, including congruence, symmetry, transformation, and measurement. Trigonometry from a geometric perspective and the use of trigonometry in problem solving are included. Topics also include coordinate geometry and visualization as well as the nature of axiomatic reasoning and the role it has played in the development of mathematics. An investigative approach involving problem solving, reasoning and proof, connections, and communication will be emphasized. Calculator and computer technology will support the investigation of these topics. Classroom resources and materials are considered. Different levels of geometric thinking will be explored. No credit for CASL concentration, minor, or area of focus. Open only to certified teachers or elementary education students. Student cannot receive credit for both MATH 442 and MATH 542. (W, AY).
Restriction(s):
Cannot enroll if Level is
Can enroll if College is Education, Health, and Human Services

MATH 443 Algebra for Teachers 3 Credit Hours
Algebraic structure is emphasized, especially as it relates to arithmetic. Emphasis is on the development of algebraic reasoning and generalizations with the appropriate pedagogy. Curriculum issues relevant to teaching algebra for conceptual understanding are included. Major topics include algebraic representations of linear, exponential, power and quadratic patterns, systems of equations, and applications. An investigative approach involving problem solving, reasoning and proof, connections and communications will be emphasized. Classroom resources and materials are considered as well as calculators and computer technology as problem-solving tools to aid in algebraic thinking. No credit for CASL concentration, minor or area of focus. Students cannot receive credit for both MATH 443 and MATH 543. (F, AY).
Restriction(s):
Cannot enroll if Level is
Can enroll if College is Education, Health, and Human Services

MATH 444 Data Anlsys,Prob&Stat forTchrs 3 Credit Hours
Concepts of probability using both experimental and theoretical models are considered with an emphasis on the use of probability models to describe physical phenomena and to make and interpret predictions. Topics in data analysis and statistics include drawing inferences from visual displays of data, applying techniques of inferential statistics, sampling and simulations to generate solutions to problems, and making appropriate inferences using best fit techniques. Evaluating data and arguments to establish validity, interpreting, calculating and solving problems related to correlation, distributions, percentiles and standard scores are also included. An investigative approach involving problem solving, reasoning and proof, connections, and communication will be emphasized. Calculator and computer technology will support the investigation of these topics. No credit for CASL concentration, minor, or area of focus. Open only to certified teachers or secondary education students. Student cannot receive credit for both MATH 444 and MATH 544. (W, AY).
Restriction(s):
Cannot enroll if Class is
Cannot enroll if Level is
Can enroll if College is Education, Health, and Human Services

MATH 449 Concepts of Calc for Teachers 3 Credit Hours
Concepts of Calculus for Teachers focuses on calculus concepts appropriate for middle school mathematics teachers and teacher-candidates. The course provides a deep understanding of the major concepts of calculus: rates of change, accumulation (net change), area, and limits. Students will experience concrete approaches to the various topics using problem solving, manipulatives and technology as appropriate, with the intent being to help the learners discover how the ideas of calculus are useful in a variety of settings. Visual, numeric and commonsense approaches are used. No credit for CASL concentration, minor, or area of focus. Open only to certified teachers or elementary education students. Students cannot receive credit for both MATH 449 and 549. (AY)
Restriction(s):
Cannot enroll if Class is

MATH 451 Advanced Calculus 4 Credit Hours
Topics for this course include properties of the real number system, point set theory for the real line and the Bolzano-Weierstrass theorem, sequences, functions of one variable, limits and continuity, differentiability, continuous nowhere-differentiable functions, Riemann integrability, Lebesgue's criterion for Riemann integrability, and series of functions. Students cannot receive credit for both MATH 451 and MATH 551. (F).
Prerequisite(s): MATH 300 and MATH 228 and MATH 227

MATH 452 Advanced Calculus II 3 Credit Hours
Includes the rigorous study of functions of two and more variables, partial differentiation and multiple integration. Special topics include: Taylor Series, Implicit Function Theorem, Weierstrass Approximation Theorem, Arzela-Ascoli Theorem. Students cannot receive credit for both MATH 452 and MATH 552. (AY,W).
Prerequisite(s): MATH 451

MATH 454 Fourier Series and Boundary Value Problems 3 Credit Hours
Fourier series and integrals. Their use in solving boundary value problems of mathematical physics by the method of separation of variables. Sturm-Liouville theory and generalized Fourier series, including those involving Bessel functions and Legendre polynomials, with applications. A minimum grade of C- is required in the prerequisite courses. Students cannot receive credit for both MATH 454 and MATH 554. (AY).
Prerequisite(s): MATH 228 and MATH 215

MATH 455 Functions of a Complex Variable with Applications 3 Credit Hours
Complex number system. Functions of a complex variable, their derivatives and integrals. Taylor and Laurent series expansions. Residue theory and applications, elementary functions, conformal mapping, and applications to physical problems. A minimum grade of C- is required in the prerequisite courses. Students cannot receive credit for both MATH 455 and MATH 555. (OC).
Prerequisite(s): MATH 228 and MATH 215
Restriction(s):
Can enroll if Level is Undergraduate

MATH 458 Introduction to Wavelets 3 Credit Hours
This course will introduce the students to theory and application of wavelets using linear algebra. Topics will include the discrete Fourier transform, the fast Fourier transform, linear transformations, orthogonal decomposition, discrete wavelet analysis, the filter bank, Haar Wavelet family, Daubechies's Wavelet family, and applications. Students cannot receive credit for both MATH 458 and MATH 558. (OC)
Prerequisite(s): MATH 217 or MATH 227
Restriction(s):
Can enroll if Class is Sophomore or Junior or Senior

MATH 462 Mathematical Modeling 3 Credit Hours
The processes of constructing, implementing, and evaluating mathematical models of "real world" phenomena are investigated. Models involving continuous and discrete mathematical constructs are considered. Deterministic and stochastic models are compared. Examples are taken from genetics, epidemiology, queuing theory, and other fields. A minimum grade of C- is required in the prerequisite courses. Students cannot receive credit for both MATH 462 and MATH 562. (W).
Prerequisite(s): MATH 215 and (MATH 227 or MATH 228)

MATH 472 Introduction to Computational Mathematics 3 Credit Hours
This course is an introduction to computational mathematics, a branch of mathematics that focuses on methods and procedures used to solve mathematical problems using computers. Topics include floating point representation, round-off error, root finding techniques, interpolation, numerical integration, methods for solving linear systems of equations, minimizing functions, optimization techniques, and methods for solving ordinary differential equations numerically. A minimum grade of C- is required in the prerequisite. Students cannot receive credit for both MATH 472 and MATH 572. (F).
Prerequisite(s): MATH 227 or MATH 228

MATH 473 Matrix Computation 3 Credit Hours
A study of the most effective methods for finding the numerical solution of problems which can be expressed in terms of matrices, including simultaneous linear equations, orthogonal projections and least squares, eigenvalues and eigenvectors, positive definite matrices, and difference and differential equations. Students cannot receive credit for both MATH 473 and MATH 573. (AY, W).
Prerequisite(s): MATH 217 or MATH 227

MATH 486 Sec School Math for Teachers 3 Credit Hours
Basic concepts, relationships, generalizations, and applications from the secondary school mathematics curriculum are discussed both from an advanced viewpoint and from the standpoint of the learner. Included are the roles of technology, problem solving, and current thinking on the teaching of secondary mathematics topics. Students cannot receive credit for both MATH 486 and MATH 586. (F).
Prerequisite(s): MATH 217 or MATH 227

MATH 492 Introduction to Topology 4 Credit Hours
Metric spaces, topological spaces, continuous maps, connectedness, compactness, separation axioms. Students cannot receive credit for both MATH 492 and MATH 592. Prior experience in a proof based course is recommended. (OC).
Prerequisite(s): MATH 300

MATH 499 Independent Studies in Math 1 to 4 Credit Hours
Independent study in mathematics for topics at the senior level. Topics and objectives chosen by agreement between student and instructor. (OC).

*An asterisk denotes that a course may be taken concurrently.

Frequency of Offering

The following abbreviations are used to denote the frequency of offering: (F) fall term; (W) winter term; (S) summer term; (F, W) fall and winter terms; (YR) once a year; (AY) alternating years; (OC) offered occasionally