

# MATHEMATICS (MATH)

## MATH 100A Intermediate Algebra

**Prerequisites:** Appropriate score on the Math Placement Exam.

**Notes:** Credit earned in MATH 100A will not count toward degree requirements.

**Description:** Review of the topics in a second-year high school algebra course taught at the college level. Includes: real numbers, 1st and 2nd degree equations and inequalities, linear systems, polynomials and rational expressions, exponents and radicals. Heavy emphasis on problem solving strategies and techniques.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 101; MATH 103

**Course and Laboratory Fee:** \$10

## MATH 101 College Algebra

**Prerequisites:** Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 100A. Credit toward the degree may only be earned in one of MATH 101, MATH 101P, or MATH 103.

**Notes:** Students with previous credit in any calculus course (Math 104, 106, 107, or 208) may not earn credit for this course.

**Description:** Real numbers, exponents, factoring, linear and quadratic equations, absolute value, inequalities, functions, graphing, polynomial and rational functions, exponential and logarithmic functions, system of equations.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** AGST 109; CHEM 105A; CHME 204; CRIM 300; MATH 102; MATH 104; METR 100; METR 140

**Course and Laboratory Fee:** \$10

## MATH 101P College Algebra Plus Foundations

**Prerequisites:** Appropriate score on the Math Placement Exam. Credit toward the degree may only be earned in one of MATH 101, MATH 101P, or MATH 103.

**Notes:** Students with previous credit in any calculus course (Math 104, 106, 107, or 208) may not earn credit for this course.

**Description:** College Algebra topics including: real numbers, exponents, factoring, linear and quadratic equations, absolute value, inequalities, functions, graphing, polynomial and rational functions, exponential and logarithmic functions, system of equations. Also includes necessary background Intermediate Algebra topics: 1st and 2nd degree equations and inequalities, linear systems, rational expressions, exponents and radicals. Heavy emphasis on problem solving strategies and techniques.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Offered:** FALL

**Prerequisite for:** MATH 102; MATH 104

## MATH 102 Trigonometry

**Prerequisites:** Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 101 or MATH 101P. Credit toward the degree may only be earned in one of MATH 102 or MATH 103.

**Notes:** Students with previous credit in any calculus course (MATH 104, MATH 106, MATH 107, or MATH 208) may not earn credit for this course.

**Description:** Trigonometric functions, identities, trigonometric equations, solution of triangles, inverse trigonometric functions and graphs. Applications of trigonometry.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** AGST 109; CHEM 109A; CHEM 113A; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; GEOL 200; MATH 104; MATH 106; METR 100; METR 140; PHYS 141; PHYS 141H; PHYS 151; PLAS 361, GEOL 361, NRES 361, SOIL 361; PLAS 458, AGRO 858, NRES 458, NRES 858, SOIL 458; PLAS 472, AGRO 872, NRES 472, NRES 872, SOIL 472

**Course and Laboratory Fee:** \$10

## MATH 103 College Algebra and Trigonometry

**Prerequisites:** Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 100A. Credit toward the degree cannot be earned in MATH 103 and any of MATH 101, MATH 101P, or MATH 102.

**Notes:** Students with previous credit in any calculus course (Math 104, 106, 107, or 208) may not earn credit for this course.

**Description:** First and second degree equations and inequalities, absolute value, functions, polynomial and rational functions, exponential and logarithmic functions, trigonometric functions and identities, laws of sines and cosines, applications, polar coordinates, systems of equations, graphing, conic sections.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded with Option

**Prerequisite for:** AGST 109; CHEM 105A; CHEM 109A; CHEM 113A; CHME 204; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; GEOL 200; MATH 104; MATH 106; METR 100; METR 140; PHYS 141; PHYS 141H; PHYS 151; PLAS 361, GEOL 361, NRES 361, SOIL 361; PLAS 458, AGRO 858, NRES 458, NRES 858, SOIL 458; SOFT 160; SOFT 160H

**Course and Laboratory Fee:** \$10

**MATH 104 Applied Calculus**

**Prerequisites:** Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 101, MATH 102 or MATH 103. Credit toward the degree may be earned in only one of MATH 106 or MATH 104

**Notes:** Students with previous credit in any version of MATH 106, MATH 107, or MATH 208 may not earn credit for this course.

**Description:** Rudiments of differential and integral calculus with applications to problems from business, economics, and social sciences.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; AECN 340; AECN 465, AECN 865, NREE 465; AGST 109; ARCH 333, CNST 305; BLAW 371H; BLAW 372; BLAW 372H; BSEN 355; CONE 221; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; ECON 215; ECON 215H; ECON 311A; ECON 311B; ECON 312A; ECON 312B; FDST 363, AGST 363; FINA 361; FINA 361A; FINA 361H; MATH 315; METR 100; METR 140; MRKT 341H, RAIK 341H; PHYS 151; PLAS 361, GEOL 361, NRES 361, SOIL 361; PLAS 472, AGRO 872, NRES 472, NRES 872, SOIL 472; SCMA 331; SCMA 335; SCMA 350; SCMA 350H

**ACE:** ACE 3 Math/Stat/Reasoning

**Course and Laboratory Fee:** \$10

**MATH 106 Calculus I**

**Prerequisites:** Appropriate score on the Math Placement Exam; or grade of P, C, or better in MATH 102 or MATH 103. Credit toward the degree may be earned in only one of MATH 106 or MATH 104

**Description:** Functions of one variable, limits, differentiation, exponential, trigonometric and inverse trigonometric functions, maximum-minimum, and basic integration theory (Riemann sums) with some applications.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; AGEN 112, BSEN 112; AGEN 225, BSEN 225; AGST 109; ARCH 333, CNST 305; BLAW 371H; BLAW 372; BLAW 372H; BSEN 355; CHEM 109A; CHME 114; CNST 241; CNST 242; CNST 251; CNST 252; CNST 306; CONE 221; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; CSCE 156H; CSCE 235; CSCE 235H; ECEN 103; ECON 215; ECON 215H; ECON 311A; ECON 311B; ECON 312A; ECON 312B; ENVE 210; FDST 363, AGST 363; FINA 361; FINA 361A; FINA 361H; GEOL 200; GEOL 410; MATH 106; MATH 107; MATH 107H; MATH 315; MECH 220; METR 100; METR 140; METR 205; MRKT 341H, RAIK 341H; PHYS 141; PHYS 141H; PHYS 151; PHYS 211; PHYS 211H; PLAS 361, GEOL 361, NRES 361, SOIL 361; PLAS 472, AGRO 872, NRES 472, NRES 872, SOIL 472; SCMA 331; SCMA 335; SCMA 350; SCMA 350H

**ACE:** ACE 3 Math/Stat/Reasoning

**Course and Laboratory Fee:** \$10

**MATH 107 Calculus II**

**Prerequisites:** A grade of P, C or better in MATH 106.

**Description:** Integration theory; techniques of integration; applications of definite integrals; sequences and series; convergence of series; power series; Taylor series and their applications.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Offered:** FALL/SPR

**Prerequisite for:** ACCT 308; ACCT 309; AREN 211; ASTR 204; BIOC 440; BLAW 371H; BLAW 372; BLAW 372H; BSEN 244; BSEN 321, CIVE 321; BSEN 321H, CIVE 321H; CHEM 109A; CHME 114; CHME 202; CHME 212; CHME 331; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; CSCE 156H; ECEN 211; ECEN 224; ECON 311A; ECON 311B; ECON 312A; ECON 312B; ENVE 210; FINA 361; FINA 361A; FINA 361H; MATH 107; MATH 208; MATH 208H; MATH 221; MATH 221H; MATH 309; MATH 314; MATH 314H; MECH 223; MECH 223H; METR 100; METR 140; METR 223; MRKT 341H, RAIK 341H; PHYS 141H; PHYS 151; PHYS 211; PHYS 211H; PHYS 212; PHYS 212H; PLAS 361, GEOL 361, NRES 361, SOIL 361; SCMA 331; SCMA 335; SCMA 350; SCMA 350H; STAT 380, RAIK 270H

**ACE:** ACE 3 Math/Stat/Reasoning

**Course and Laboratory Fee:** \$10

**MATH 107H Honors: Calculus II**

**Prerequisites:** Good standing in the University Honors Program or by invitation; and a grade of "B" or better in MATH 106 or equivalent. Credit toward the degree cannot be earned in MATH 107 and MATH 107H.

**Description:** For course description, see MATH 107.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; AREN 211; ASTR 204; BIOC 440; BLAW 371H; BLAW 372H; BSEN 244; CHME 202; CHME 212; CHME 331; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; CSCE 156H; ECEN 211; ECEN 224; ECON 311A; ECON 311B; ECON 312A; ECON 312B; ENVE 210; FINA 361; FINA 361A; FINA 361H; MATH 208; MATH 208H; MATH 221; MATH 221H; MATH 309; MATH 314; MATH 314H; MECH 223; MECH 223H; METR 100; METR 140; METR 223; MRKT 341H, RAIK 341H; PHYS 141H; PHYS 151; PHYS 211; PHYS 211H; PHYS 212; PHYS 212H; PLAS 361, GEOL 361, NRES 361, SOIL 361; SCMA 331; SCMA 335; SCMA 350; SCMA 350H; STAT 380, RAIK 270H

**ACE:** ACE 3 Math/Stat/Reasoning

**MATH 107R Analytic Geometry and Calculus II**

**Prerequisites:** A grade of P, C or better in MATH 106.

**Notes:** Open only to students who previously completed the 5 credit hour MATH 107 at UNL and wish to improve their grade.

**Description:** Integration theory, techniques of integration, applications of definite integrals, series, Taylor series, vectors, cross and dot products, lines and planes, space curves.

**Credit Hours:** 5

**Max credits per semester:** 5

**Max credits per degree:** 5

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; ASTR 204; BLAW 371H; BLAW 372; BSEN 244; CHME 202; CHME 212; CHME 331; CRIM 300; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; ECEN 211; ECON 311A; ECON 311B; ECON 312A; ECON 312B; FINA 361; FINA 361A; FINA 361H; MATH 107; MATH 208; MATH 221; MATH 221H; MATH 314; MECH 223; METR 100; METR 140; METR 223; MRKT 341H, RAIK 341H; PHYS 141H; PHYS 151; PHYS 211H; PHYS 212; PLAS 361, GEOL 361, NRES 361, SOIL 361; SCMA 331; SCMA 335; SCMA 350; SCMA 350H

**MATH 191 Special Topics in Mathematics**

**Description:** Topics vary.

**Credit Hours:** 1-6

**Min credits per semester:** 1

**Max credits per semester:** 6

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**Prerequisite for:** METR 100; METR 140

**MATH 203 Contemporary Mathematics**

**Notes:** Credit toward the degree cannot be earned in both MATH 203 and MATH 203J.

**Description:** Applications of quantitative reasoning and methods to problems and decision making in the areas of management, statistics, and social choice. Includes networks, critical paths, linear programming, sampling, central tendency, inference, voting methods, power index, game theory, and fair division problems.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ACE:** ACE 3 Math/Stat/Reasoning

**MATH 208 Calculus III**

**Prerequisites:** A grade of P, C or better in MATH 107

**Description:** Vectors and surfaces, parametric equations and motion, functions of several variables, partial differentiation, maximum-minimum, Lagrange multipliers, multiple integration, vector fields, path integrals, Green's Theorem, and applications.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; ACTS 445; ASTR 204; BLAW 371H; BLAW 372; BLAW 372H; CHME 114; CHME 202; CHME 332; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; CSCE 156H; ECEN 305; ECEN 306; ECON 311A; ECON 311B; ECON 312A; ECON 312B; ENVE 210; FINA 361; FINA 361A; FINA 361H; MATH 208; MATH 221; MATH 314; MECH 223H; MECH 318; MECH 321; MECH 325; MECH 325H; MECH 373; MECH 373H; MECH 421, MECH 821, ENGR 421; METR 311; MRKT 341H, RAIK 341H; PHYS 141H; PHYS 151; PHYS 211; PHYS 211H; PHYS 213; PHYS 213H; SCMA 331; SCMA 335; SCMA 350; SCMA 350H; STAT 262; STAT 462

**ACE:** ACE 3 Math/Stat/Reasoning

**MATH 208H Honors: Calculus III**

**Prerequisites:** Good Standing in the University Honors Program and a grade of P, C, or better in MATH 107 or MATH 107H. Credit toward the degree cannot be earned in MATH 208 and MATH 208H.

**Description:** Vectors and surfaces, parametric equations and motion, functions of several variables, partial differentiation, maximum-minimum, Lagrange multipliers, multiple integration, vector fields, path integrals, Green's Theorem, and applications.

**Credit Hours:** 4

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option

**Prerequisite for:** ACCT 308; ACCT 309; ACTS 445; ASTR 204; BLAW 371H; BLAW 372; BLAW 372H; CHME 114; CHME 202; CHME 332; CSCE 155A; CSCE 155E, ECEN 155E; CSCE 155H; CSCE 155N; CSCE 155T; CSCE 156, ECEN 156; CSCE 156H; ECEN 305; ECEN 306; ECON 311A; ECON 311B; ECON 312A; ECON 312B; ENVE 210; FINA 361; FINA 361A; FINA 361H; MATH 208; MATH 221; MATH 314; MECH 223H; MECH 318; MECH 321; MECH 325; MECH 325H; MECH 373; MECH 373H; MECH 421, MECH 821, ENGR 421; METR 311; MRKT 341H, RAIK 341H; PHYS 141H; PHYS 151; PHYS 211H; PHYS 213; PHYS 213H; SCMA 331; SCMA 335; SCMA 350; SCMA 350H; STAT 462

**ACE:** ACE 3 Math/Stat/Reasoning

**MATH 221 Differential Equations**

**Prerequisites:** A grade of P, C, or better in MATH 107 or MATH 107H

**Description:** First- and second-order methods for ordinary differential equations including: separable, linear, Laplace transforms, linear systems, and some applications.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** AGEN 303, BSEN 303; AGEN 344, BSEN 344; AGEN 350, BSEN 350; AGEN 953; AGEN 957, BSEN 957, CIVE 957, GEOL 957; BSEN 260, AGEN 260; BSEN 311; BSEN 317; BSEN 943; BSEN 954, NRES 954; CHME 312; CHME 815; CHME 825; CHME 835; CIVE 310; CIVE 310H; ECEN 213; ECEN 215; ECEN 216; ECEN 304; ECEN 306; ENGR 410; MATH 430; MECH 310; MECH 310H; MECH 318; MECH 330; MECH 381; MECH 449, MECH 849; MECH 454, MECH 854; MECH 480, MECH 880; MECH 810; MECH 881; MECH 925; MECH 933; MECH 936; MECH 938; MECH 939; METR 312; PHYS 311; PHYS 422, PHYS 822, ECEN 422, ECEN 822

**MATH 221H Honors:Differential Equations**

**Prerequisites:** Good Standing in the University Honors Program and a grade of P, C, or better in MATH 107 or MATH 107H. Credit toward the degree cannot be earned in MATH 221 and MATH 221H.

**Description:** For course description, see MATH 221.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded

**Prerequisite for:** AGEN 303, BSEN 303; AGEN 344, BSEN 344; AGEN 350, BSEN 350; BSEN 260, AGEN 260; BSEN 311; BSEN 317; CHME 312; CIVE 310; CIVE 310H; ECEN 213; ECEN 215; ECEN 216; ECEN 304; ECEN 306; ENGR 410; MATH 430; MECH 310; MECH 310H; MECH 318; MECH 330; MECH 810; PHYS 311

**MATH 300 Mathematics Matters**

**Prerequisites:** TEAC 308 or TEAC 416D or parallel.

**Notes:** Admission to the College of Education & Human Sciences and removal of math entrance deficiencies is required. Credit toward the degree may be earned in only one of: MATH 300 or MATH 300M.

**Description:** Numbers and operations. Develop an understanding of mathematics taught in the elementary school.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 301; TEAC 297E; TEAC 308

**Groups:** Introductory Mathematics

**MATH 301 Geometry Matters**

**Prerequisites:** MATH 300

**Description:** Geometry and measurement. Develop an understanding of geometry as taught in the elementary school.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 302 Math Modeling**

**Notes:** MATH 300 is a strongly recommended prerequisite. Intended for middle grades teaching endorsement majors with a mathematics emphasis and/or to elementary education majors who want a mathematics concentration.

**Description:** Using mathematics to model solutions or relationships for realistic problems taken from the middle school curriculum. The mathematics for these models are a mix of algebra, geometry, sequences (dynamical systems, queuing theory), functions (linear, exponential, logarithmic), and logic. Mathematical terminology, concepts and principles. Calculator based lab devices, graphing calculators, and computers as tools to collect data, to focus on concepts and ideas, and to make the mathematics more accessible.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 309 Introduction to Mathematical Proofs**

**Prerequisites:** A grade of P, C, or better in MATH 107 or MATH 107H

**Description:** Basic set theory; elements of logic and types of proofs; induction; study of relations and functions; and cardinality of sets.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 310; MATH 325; MATH 398; MATH 412; MATH 430; MATH 450; MATH 452; MATH 460; MATH 471

**MATH 310 Introduction to Modern Algebra**

**Prerequisites:** A grade of P, C, or better in MATH 309

**Description:** Elementary number theory, including induction, the Fundamental Theorem of Arithmetic, and modular arithmetic. Introduction to rings and fields as natural extension of the integers. Particular emphasis on the study of polynomials with coefficients in the rational, real, or complex numbers.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 325; MATH 398; MATH 412; MATH 417; MATH 430; MATH 450; MATH 452; MATH 460; MATH 471

**MATH 314 Linear Algebra**

**Prerequisites:** A grade of P, C, or better in MATH 107 or MATH 107H.

Credit toward the degree may be earned in only one of the following: MATH 314 or MATH 314H or MATH 315.

**Description:** Fundamental concepts of linear algebra, including properties of matrix arithmetic, systems of linearequations, vector spaces, inner products, determinants, eigenvalues and eigenvectors, and diagonalization.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** CSCE 970; ECEN 215; MATH 430; MATH 432; MECH 350; STAT 301; STAT 871

**MATH 314H Honors: Linear Algebra**

**Prerequisites:** Good Standing in the University Honors Program and a grade of P, C, or better in MATH 107 or MATH 107H. Credit toward the degree may be earned in only one of the following: MATH 314 or MATH 314H or MATH 315.

**Description:** For course description, see MATH 314.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** ECEN 215; MATH 430; MATH 432; MECH 350; STAT 871

**MATH 315 Linear Algebra for Data Science**

**Prerequisites:** A grade of P, C, or better in MATH 104 or MATH 106. Credit toward the degree may be earned in only one of the following: MATH 314 or MATH 314H or MATH 315.

**Notes:** MATH 315 cannot be used toward a major in Mathematics.

**Description:** Fundamental concepts of linear algebra, including properties of matrix arithmetic, systems of linear equations, vector spaces, inner products, determinants, eigenvalues and eigenvectors, and diagonalization, with emphasis in data science applications.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 432

**MATH 325 Elementary Analysis**

**Prerequisites:** A grade of P, C, or better in MATH 309 or MATH 310.

**Description:** An introduction to mathematical reasoning, construction of proofs, and careful mathematical writing in the context of continuous mathematics and calculus. Topics may include the real number system, limits and continuity, the derivative, integration, and compactness in terms of the real number system.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** MATH 398; MATH 412; MATH 425; MATH 430; MATH 450; MATH 452; MATH 460; MATH 471

**MATH 391 Special Topics in Mathematics**

**Prerequisites:** Permission.

**Description:** Topics vary.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**MATH 394 Independent Study in Mathematics**

**Prerequisites:** Permission

**Description:** Independent reading or research directed by a faculty member.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**MATH 398 Research Experience in Mathematics**

**Prerequisites:** MATH 309, MATH 310, or MATH 325

**Description:** An introduction to open, unsolved problems in pure and applied mathematics. Development of foundational understanding necessary to approach open problems. Engagement in data collection, forming hypotheses, problem solving, and other creative aspects of mathematical research. Discussion about how to find and read existing mathematical research papers, and emphasis on effective mathematical writing and communication.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**Experiential Learning:** Research

**MATH 399 Undergraduate Thesis**

**Prerequisites:** Permission.

**Description:** Independent research leading to an undergraduate thesis.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**MATH 399H Honors Undergraduate Thesis**

**Prerequisites:** Permission. Credit toward the degree cannot be earned in both MATH 399 and MATH 399H.

**Description:** Independent research and writing leading to an undergraduate thesis.

**Credit Hours:** 1-3

**Min credits per semester:** 1

**Max credits per semester:** 3

**Max credits per degree:** 6

**Grading Option:** Graded with Option

**MATH 407 Mathematics for High School Teaching I**

**Crosslisted with:** MATH 807

**Prerequisites:** MATH 208/208H and MATH 309 or MATH 310.

**Notes:** Open only MATH majors with a declared Education option.

**Description:** Analysis of the connections between college mathematics and high school algebra and precalculus.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Offered:** SPRING

**MATH 408 Mathematics for High School Teaching II**

**Crosslisted with:** MATH 808

**Prerequisites:** MATH 412 and MATH 309 or MATH 310.

**Notes:** Open only MATH majors with a declared Education option.

**Description:** Analysis of the connections between college mathematics and high school algebra and geometry.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Offered:** FALL

**MATH 412 Modern Geometry****Prerequisites:** MATH 309, MATH 310, or MATH 325**Description:** Modern geometry from multiple points of view, such as axiomatic, transformational, or analytic. Applications of geometry. Additional topics vary, but can include projective geometry, hyperbolic geometry, or Euclidean constructions.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**Offered:** FALL**MATH 415 Theory of Linear Transformations****Crosslisted with:** MATH 815**Prerequisites:** MATH 314/814; and MATH 309, MATH 310, or MATH 325.**Description:** Topics fundamental to the study of linear transformations on finite and infinite dimensional vector spaces over the real and complex number fields including: subspaces, direct sums, quotient spaces, dual spaces, matrix of a transformation, adjoint map, invariant subspaces, triangularization and diagonalization. Additional topics may include: Riesz Representation theorem, projections, normal operators, spectral theorem, polar decomposition, singular value decomposition, determinant as an n-linear functional, Cayley-Hamilton theorem, nilpotent operators, and Jordan canonical form.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**MATH 417 Group Theory****Prerequisites:** A grade of P, C, or better in MATH 310**Description:** Elementary group theory, including cyclic, dihedral, and permutation groups; subgroups, cosets, normality, and quotient groups; fundamental isomorphism theorems; the theorems of Cayley, Lagrange, and Cauchy; and if time allows, Sylow's theorems.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**ACE:** ACE 10 Integrated Product**MATH 423 Complex Analysis****Crosslisted with:** MATH 823**Prerequisites:** A grade of P, C, or better in MATH 208 or MATH 208H**Description:** Complex numbers, functions of complex variables, analytic functions, complex integration, Cauchy's integral formulas, Taylor and Laurent series, calculus of residues and contour integration, conformal mappings, harmonic functions. Applications of these concepts in engineering, physical sciences, and mathematics.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**MATH 424 Introduction to Partial Differential Equations****Crosslisted with:** MATH 824**Prerequisites:** A grade of P, C, or better in MATH 208/208H and MATH 221/221H.**Notes:** Not open to MA or MS students in mathematics or statistics.**Description:** Derivation of the heat, wave, and potential equations; separation of variables method of solution; solutions of boundary value problems by use of Fourier series, Fourier transforms, eigenfunction expansions with emphasis on the Bessel and Legendre functions; interpretations of solutions in various physical settings.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**Prerequisite for:** MECH 812**MATH 425 Mathematical Analysis****Prerequisites:** A grade of P, C, or better in MATH 325**Description:** Real number system, topology of Euclidean space and metric spaces, compactness, sequences, series, convergence and uniform convergence, and continuity and uniform continuity.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**MATH 428 Principles of Operations Research****Crosslisted with:** MATH 828**Prerequisites:** MATH 314 or MATH 314H; and RAIK 270H, STAT 380, or MECH 321.**Description:** Introduction to techniques and applications of operations research. Includes linear programming, queueing theory, decision analysis, network analysis, and simulation.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**ACE:** ACE 10 Integrated Product**MATH 430 Ordinary Differential Equations****Prerequisites:** MATH 221 or MATH 221H; MATH 314 or MATH 314H; MATH 309, MATH 310, or MATH 325.**Description:** Qualitative behavior of solutions of systems of differential equations, including existence and uniqueness, extendibility, and periodic solutions. The Putzer algorithm, Floquet theory, matrix norms, linearization, stability theory, and period-doubling and chaos.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option**MATH 432 Mathematics of Machine Learning****Prerequisites:** A grade of P, C, or better in MATH 314 or MATH 315**Description:** An introduction to the essential mathematical content necessary to understand machine learning, its opportunities, and its challenges. Differentiation in higher dimensions, gradient descent method, optimization over convex and non-convex domains, neural networks, and computer implementation of machine learning algorithms to solve benchmark problems.**Credit Hours:** 3**Max credits per semester:** 3**Max credits per degree:** 3**Grading Option:** Graded with Option

**MATH 433 Nonlinear Optimization**

**Crosslisted with:** MATH 833

**Prerequisites:** MATH 208/208H; MATH 314/314H; and MATH 309, MATH 310, or MATH 325.

**Description:** Mathematical theory of unconstrained and constrained optimization for nonlinear multivariate functions, particularly iterative methods, such as quasi-Newton methods, least squares optimization, and convex programming. Computer implementation of these methods.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Offered:** SPRING

**MATH 435 Math in the City**

**Prerequisites:** Data Science Major or Mathematics Major; Senior Standing

**Description:** A research experience modeling problems of current interest to the local community, businesses, or government.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ACE:** ACE 10 Integrated Product

**Experiential Learning:** Case/Project-Based Learning

**MATH 439 Mathematical Biology**

**Crosslisted with:** MATH 839

**Prerequisites:** MATH 221/221H & MATH 314/314H.

**Description:** Discrete and continuous models in ecology: population models, predation, food webs, the spread of infectious diseases, and life histories. Elementary biochemical reaction kinetics; random processes in nature. Use of software for computation and graphics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 440 Numerical Analysis I**

**Crosslisted with:** CSCE 440, CSCE 840, MATH 840

**Prerequisites:** CSCE 155A, CSCE 155E, CSCE 155H, CSCE 155N, CSCE 155T, or SOFT 160; MATH 107. Credit toward the degree may be earned in only one of the following: CSCE440/MATH 440 and MECH 480

**Description:** Principles of numerical computing and error analysis covering numerical error, root finding, systems of equations, interpolation, numerical differentiation and integration, and differential equations. Modeling real-world engineering problems on digital computers. Effects of floating point arithmetic.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** CSCE 942

**Course and Laboratory Fee:** \$20

**MATH 445 Number Theory**

**Crosslisted with:** MATH 845

**Prerequisites:** MATH 310.

**Description:** Fundamentals of number theory, including congruences, primality tests, factoring methods. Diophantine equations, quadratic reciprocity, continued fractions, and elliptic curves.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 447 Numerical Methods for Applied Math**

**Crosslisted with:** MATH 847

**Prerequisites:** MATH 208/208H, MATH 221/221H & MATH 314/314H

**Description:** Numerical methods for approximate solutions of applied mathematics problems. Topics typically considered include numerical solution of linear systems of equations, approximation of eigenvalues and eigenvectors, numerical solution of nonlinear systems of equations, and numerical solution of initial value problems for ordinary differential equations. Given time, mathematical applications in optimization, machine learning, or data science may be considered.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Prerequisite for:** CSCE 942

**MATH 450 Combinatorics**

**Prerequisites:** MATH 309, MATH 310, or MATH 325.

**Description:** Theory of enumeration and/or existence of arrangements of objects: Pigeonhole principle, inclusion-exclusion, recurrence relations, generating functions, systems of distinct representatives, combinatorial designs and other applications.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 452 Graph Theory**

**Prerequisites:** MATH 309, MATH 310, or MATH 325.

**Description:** Theory of directed and undirected graphs. Trees, circuits, subgraphs, matrix representations, coloring problems, and planar graphs. Methods which can be implemented by computer algorithms.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Offered:** FALL

**MATH 460 History of Mathematics**

**Prerequisites:** MATH 309, MATH 310, or MATH 325

**Description:** An overview of the development of modern mathematics, particularly the development of algebra, geometry, and calculus. Case studies, such as solvability of polynomial equations, the role of the parallel postulate in geometry, the development of analytic geometry, or additional topics.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**Offered:** FALL

**MATH 471 Introduction to Topology**

**Prerequisites:** MATH 309, MATH 310, or MATH 325.

**Description:** Elementary point-set and geometric topology. Point-set topics include topological spaces, continuous functions, homeomorphisms, connectedness, compactness, quotient spaces. Geometric topology topics include Euler characteristic, classification of surfaces, and other applications.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 487 Probability Theory**

**Crosslisted with:** MATH 887

**Prerequisites:** MATH 314 or MATH 314H; and MATH 309, MATH 310, or MATH 325.

**Description:** Probability, conditional probability, Bayes' theorem, independence, discrete and continuous random variables, density and distribution functions, multivariate distributions, probability and moment generating functions, the central limit theorem, convergence of sequences of random variables, random walks, Poisson processes and applications.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**MATH 489 Stochastic Processes**

**Crosslisted with:** MATH 889

**Prerequisites:** MATH 314 or MATH 314H; and STAT 380 or RAIK 270H.

**Description:** Markov chains, continuous-time Markov processes, the Poisson process, Brownian motion, introduction to stochastic calculus.

**Credit Hours:** 3

**Max credits per semester:** 3

**Max credits per degree:** 3

**Grading Option:** Graded with Option

**ACE:** ACE 10 Integrated Product

**MATH 493 Seminar in Mathematics**

**Crosslisted with:** MATH 893

**Prerequisites:** Permission.

**Description:** Topics in one or more branches of mathematics.

**Credit Hours:** 1-4

**Min credits per semester:** 1

**Max credits per semester:** 4

**Max credits per degree:** 8

**Grading Option:** Graded with Option

**MATH 494 Independent Study in Mathematics**

**Prerequisites:** Permission.

**Description:** Directed reading or research with a faculty member.

**Credit Hours:** 1-4

**Min credits per semester:** 1

**Max credits per semester:** 4

**Max credits per degree:** 4

**Grading Option:** Graded with Option