Mathematics (MATH)

Course information contained within the Bulletin is accurate at the time of publication in August 2023 but is subject to change. For the most up-to-date course information, please refer to the Course Catalog.

MATH 0701. Basic Mathematics for Today's World. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course surveys a variety of mathematical topics. Topics include numeracy with an emphasis on estimation and fluency with large numbers, evaluating expressions and formulas, rates, ratios, proportions, and percentages, solving equations, linear models, data interpretations including graphs and tables, verbal, algebraic and graphical representations of functions, exponential models. The course will help students develop conceptual understanding and acquire multiple strategies for solving problems. It will prepare students for success in future quantitative courses and will help them develop skills for the workplace and for everyday life. Please note that Math 0701 is no longer a prerequisite for MATH 1021, College Algebra, or STAT 1001, Quantitative Methods for Business I. Students whose program of studies requires one of these two courses must complete MATH 0702, Intermediate Algebra, instead.

Repeatability: This course may not be repeated for additional credits.

MATH 0702. Intermediate Algebra. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I, and Summer II.
This course is designed as an intermediate algebra course that prepares students for the topics covered in Math 1021. This course covers the real number system, basic properties of real numbers, operations with fractional expressions, simplifying complex fractions, powers and roots, operations with radicals, graphing linear equations and inequalities, and factoring of polynomials.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 1021, 'Y' in MC2, 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC2A, 'Y' in MC3A, 'Y' in MC6A, 'Y' in MC3S, 'Y' in MC2D, 'Y' in MC2T, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0823. Math for a Digital World. 4 Credit Hours.
This course is not offered every year.
This course is about becoming an "informed user" of quantitative information. Do numbers make us more or less rational? What does "free" really mean? What's the difference between "correlation" and "cause"? How can we be misled by numbers? How can we make better decisions and have more effective discussions by understanding mathematics? Does it make sense to play the lottery? What are your chances of drawing the card you in need in a poker game? How long will it take you to save a million dollars assuming interest is earned but you keep spending? How does math play into the digital world that surrounds us, whether it is email, online tools or the creation of passwords, IDs or serial numbers? These and many other questions will be explored and answered throughout the course. NOTE: (1) This course fulfills the Quantitative Literacy (GQ) requirement for students under GenEd and a Quantitative Reasoning (QA or QB) requirement for students under Core. (2) Duplicate Course: Students cannot receive credit for CIS 0823/0923 if they have successfully completed MATH 0823/0923.

Course Attributes: GQ

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0822 (may be taken concurrently), any MATH course numbered 0824 to 0922 (may be taken concurrently), any MATH course numbered 0924 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0824. Mathematical Patterns. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course will convey the essence of mathematics and its current breadth. It sets out to describe mathematics as a rich and living part of human culture, and is intended for the general student with minimal mathematical knowledge. Exposure to this subject matter will contribute to students' educational breadth and intellectual development by sharpening their problem-solving skills, enhancing their understanding of logical reasoning and analysis, and strengthening their ability to use language and symbolic expression in a disciplined manner. The course will consist of a series of vignettes. Topics may include problem solving, voting theory, graph theory, finance, mathematical models, cryptography, statistics and probability. NOTE: This course fulfills the Quantitative Literacy (GQ) requirement for students under GenEd and a Quantitative Reasoning (QA or QB) requirement for students under Core. Students cannot receive credit for MATH 0824 if they have successfully completed MATH 0924.

Course Attributes: GQ

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0823 (may be taken concurrently), any MATH course numbered 0825 to 0923 (may be taken concurrently), any MATH course numbered 0925 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0828. Critical Reasoning and Problem Solving. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I, and Summer II.
The course teaches students how to deal with and solve complex problems by confronting them with critical analysis. We look at these problems both from an historical perspective and the practical view of how and when these types of problems affect the students' everyday lives. The course takes students through several key mathematical disciplines, including probability and statistics, including the hallmark of probability - reasoning under uncertainty - as well as set theory and counting techniques and graphing, especially with Venn diagrams, a skill they will find beneficial as the world turns to technology and graphics. For example, when we introduce probability, we cover the first dramatic application of the discipline, Mendel's discovery of the centuries-old problem of explaining the scientific laws of heredity as he gives birth to genetics. We also cover Mendel's use of statistics. This leads us to study modern uses of the same concepts in areas such as medicine - how to evaluate statistical studies and how to analyze topics such as false positives - as well as the application of DNA in areas such as how it has significantly changed our justice system.

Course Attributes: GQ

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0827 (may be taken concurrently), any MATH course numbered 0829 to 0927 (may be taken concurrently), any MATH course numbered 0929 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0923. Honors Math for a Digital World. 4 Credit Hours.
This course is not offered every year. This course is about becoming an "informed user" of quantitative information. Do numbers make us more or less rational? What does "free" really mean? What's the difference between "correlation" and "cause"? How can we be misled by numbers? How can we make better decisions and have more effective discussions by understanding mathematics? Does it make sense to play the lottery? What are your chances of drawing the card you in need in a poker game? How long will it take you to save a million dollars assuming interest is earned but you keep spending? How does math play into the digital world that surrounds us, whether it is email, online tools or the creation of passwords, IDs or serial numbers? These and many other questions will be explored and answered throughout the course. NOTE: (1) This course fulfills the Quantitative Literacy (GQ) requirement for students under GenEd and a Quantitative Reasoning (QA or QB) requirement for students under Core. (2) Duplicate Course: Students cannot receive credit for CIS 0823/0923 if they have successfully completed MATH 0823/0923.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: GQ, HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0822 (may be taken concurrently), any MATH course numbered 0824 to 0922 (may be taken concurrently), any MATH course numbered 0924 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC3A, 'Y' in MC6A, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0924. Honors Mathematical Patterns. 4 Credit Hours.
This course is typically offered in Fall and Spring.
This course will convey the essence of mathematics and its current breadth. It sets out to describe mathematics as a rich and living part of human culture, and is intended for the general student with minimal mathematical knowledge. Exposure to this subject matter will contribute to students' educational breadth and intellectual development by sharpening their problem-solving skills, enhancing their understanding of logical reasoning and analysis, and strengthening their ability to use language and symbolic expression in a disciplined manner. The course will consist of a series of vignettes. Topics may include problem solving, voting theory, graph theory, finance, mathematical models, cryptography, statistics and probability. (This is an Honors course.) NOTE: This course fulfills the Quantitative Literacy (GQ) requirement for students under GenEd and a Quantitative Reasoning (QA or QB) requirement for students under Core. Students cannot receive credit for MATH 0924 if they have successfully completed MATH 0824.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: GQ, HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0823 (may be taken concurrently), any MATH course numbered 0825 to 0923 (may be taken concurrently), any MATH course numbered 0925 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC3A, 'Y' in MC6A, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 0928. Honors Critical Reasoning and Problem Solving. 4 Credit Hours.
The course teaches students how to deal with and solve complex problems by confronting them with critical analysis. We look at these problems both from an historical perspective and the practical view of how and when these types of problems affect the students' everyday lives. The course takes students through several key mathematical disciplines, including probability and statistics, including the hallmark of probability - reasoning under uncertainty - as well as set theory and counting techniques and graphing, especially with Venn diagrams, a skill they will find beneficial as the world turns to technology and graphics. For example, when we introduce probability, we cover the first dramatic application of the discipline, Mendel's discovery of the centuries-old problem of explaining the scientific laws of heredity as he gives birth to genetics. We also cover Mendel's use of statistics. This leads us to study modern uses of the same concepts in areas such as medicine - how to evaluate statistical studies and how to analyze topics such as false positives - as well as the application of DNA in areas such as how it has significantly changed our justice system.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: GQ, HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, any MATH course numbered 0800 to 0827 (may be taken concurrently), any MATH course numbered 0829 to 0927 (may be taken concurrently), any MATH course numbered 0929 to 1041 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3A, 'Y' in MC6A, 'Y' in MATW, 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 1013. Elements of Statistics. 3 Credit Hours.
This course is typically offered in Fall, Spring, and Summer II.
This course provides a firm foundation for the study of statistics in other fields. Although no one field is emphasized to the exclusion of others, applications are drawn from psychology, political science, exercise science, and other areas. NOTE: This course can be used to satisfy the university Core Quantitative Reasoning B (QB) requirement. Although it may be usable towards graduation as a major requirement or university elective, it cannot be used to satisfy any of the university GenEd requirements. See your advisor for further information.

Course Attributes: QB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (any MATH course numbered 0701 to 0702 (C or higher), any MATH course numbered 0800 to 1012 (may be taken concurrently), any MATH course numbered 1014 to 1021 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC3A, 'Y' in MC6A, 'Y' in MA01, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3S, 'Y' in CRMA18, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 1015. Introduction to Numbers & Figures. 4 Credit Hours.
This course is typically offered in Fall, Spring, and Summer I.
This is a course intended for students wishing to familiarize themselves with basic arithmetic and geometric concepts. Subjects include the real numbers, the decimal system, and fractions, elementary number theory (primes, gcd, lcm, rational and irrational numbers), and geometry (angles, triangles, polygons, polyhedra, circles, spheres, symmetry, congruence, and similarity).

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (any MATH course numbered 0701 to 0702, MATH 1021 (may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC3A, 'Y' in MC6A, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3S, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 1018. Mathematics for Business. 3 Credit Hours.
This course is not offered every year.
Fundamentals of finite mathematics necessary for a business student to pursue statistics and other quantitatively oriented business courses. Topics and illustrations are specifically directed to applications in business and economics. Topics include algebraic concepts; linear, quadratic, polynomial and rational functions; logarithm and exponential functions; elementary matrix manipulations. Fitting of curves, interest rate calculations, present and future values of annuities are some of the specific applications. Use of a graphing calculator. NOTE: (1) Duplicate Course: Students cannot receive credit for Math 1018 if they have successfully completed Statistics 1001. (2) This course can be used to satisfy the university Core Quantitative Reasoning A (QA) requirement. Although it may be usable towards graduation as a major requirement or university elective, it cannot be used to satisfy any of the university GenEd requirements. See your advisor for further information.

Course Attributes: QA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (any MATH course numbered 0701 to 0702 (C or higher), any MATH course numbered 1021 to 1022 (D or higher; may be taken concurrently), 'Y' in MC3, 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC3A, 'Y' in MC6A, 'Y' in MA01, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), 'Y' in MC3S, 'Y' in CRMA18, 'Y' in MC3D, 'Y' in MC3O, 'Y' in MC3T, or 'Y' in MC6T)

MATH 1019. Lab for College Algebra. 2 Credit Hours.
This 2-credit course is intended as a supplement to MATH 1021 College Algebra for students with a Math GQ/1015 ALEKS math placement. The course will cover the particular intermediate algebra concepts that are necessary background for success in College Algebra.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 0702, 'Y' in MC3, or 'Y' in MC4)

MATH 1021. College Algebra. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course covers polynomial, rational and algebraic expressions, equations and inequalities. It also includes some topics in graphing, an introduction to the concept of a function, and a brief introduction to the exponential and logarithmic functions. NOTE: This course can be used to satisfy the university Core Quantitative Reasoning A (QA) requirement. Although it may be usable towards graduation as a major requirement or university elective, it cannot be used to satisfy any of the university GenEd requirements. See your advisor for further information.

Course Attributes: QA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (MATH 0702 (C or higher), MATH 1015 (C or higher), MATH 1022 (D or higher), 'Y' in MC4, 'Y' in MC5, 'Y' in MC6, 'Y' in MC6A, 'Y' in MA01, 'Y' in MA02, STAT 1001 (may be taken concurrently), 'Y' in STT2, STAT 1102 (may be taken concurrently), STAT 1902 (may be taken concurrently), (MATH 0702 and MATH 1019 (CR or higher; may be taken concurrently)), ('Y' in MC3 and MATH 1019 (CR or higher; may be taken concurrently)), 'Y' in CRMA01, 'Y' in CRMA03, or 'Y' in MC6T)

MATH 1022. Precalculus. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course is designed to prepare students for the calculus courses. Topics include functions and function operations, one-to-one and inverse functions, exponential and logarithmic functions, trigonometric functions, inverse trigonometric functions, basic trigonometric identities, polar coordinates, and an introduction to vectors. The course also contains a brief review of basic algebra. NOTE: This course can be used to satisfy the university Core Quantitative Reasoning A (QA) requirement. Although it may be usable towards graduation as a major requirement or university elective, it cannot be used to satisfy any of the university GenEd requirements. See your advisor for further information.

Course Attributes: QA

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D (except where noted) in (MATH 1021 (C or higher), (MATH 1021 (C- or higher) and MATH 1023 (CR or higher; may be taken concurrently)), MATH 1041, MATH 1038, 'Y' in MC5, 'Y' in MC6, 'Y' in MA03, 'Y' in MC6A, 'Y' in MATW, 'Y' in CRMA04, or 'Y' in MC6T)

MATH 1023. Lab for Precalculus. 1 Credit Hour.
This is a 1-credit course to be taken as a supplement to Math 1022: Precalculus for students with a C- in the prerequisite Math 1021: College Algebra. The course supplements Precalculus by giving an in-depth review of the College Algebra concepts, in the context of Precalculus, that are necessary background for success in Precalculus.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 1021.

MATH 1031. Differential and Integral Calculus. 4 Credit Hours.
This course is typically offered in Fall and Spring.
This is a calculus course in the reform style that will introduce students to the basic concepts of differential and integral calculus. The emphasis of the course will be on understanding the concepts (intuitively rather than rigorously). However, the course will also cover the basic techniques of differentiation and some techniques of integration. NOTE: (1) This is the course appropriate for those students who are taking calculus in order to fulfill the quantitative core requirements. (2) This course can be used to satisfy the university Core Quantitative Reasoning B (QB) requirement or the GenEd Quantitative Literacy (GQ) requirement.

Course Attributes: QB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1021, 'Y' in MC5, 'Y' in MC6, 'Y' in MA03, 'Y' in MC6A, 'Y' in CRMA04, or 'Y' in MC6T)

MATH 1033. Computing in MATLAB. 1.5 Credit Hour.
This course is designed as an introduction to MATLAB and as preparation for computing in undergraduate applied mathematics courses. Topics include computer arithmetic, vectors and matrices, graphics, loops, functions, and conditional operators. No prior programming or MATLAB skills are required.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1022, MATH 1039 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in CRMA05, 'Y' in CRMA07, or 'Y' in MC6T)

MATH 1034. Applications in MATLAB. 1.5 Credit Hour.
This course is designed as a supplement to MATH 1033 Computing in MATLAB and will introduce students to some particular applications using MATLAB. Topics covered will require students to reinforce their programming skills while exposing them to a variety of problems where computation is useful and necessary. After completing the course, students will be better prepared for the use of computing in more advanced undergraduate courses, research projects, and future internships/employment.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1022, MATH 1039 (may be taken concurrently), 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in CRMA05, 'Y' in CRMA07, or 'Y' in MC6T) and MATH 1033 (C- or higher)

MATH 1039. Lab for Calculus I. 1 Credit Hour.
This course is typically offered in Fall and Spring.
This is the lab component of MATH 1041, a first semester calculus course that involves both theory and applications. MATH 1039 is required for students who earned a grade of C- in MATH 1022 Precalculus. Students with no previous calculus experience or those needing extra review of algebra and precalculus topics are strongly encouraged to register for MATH 1039. Topics include algebra and precalculus in the context of the topics covered in MATH 1041.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D (except where noted) in (MATH 1022 (C- or higher), MATH 1041, MATH 1042, MATH 1044, MATH 1941, MATH 1942, MATH 1951, 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, or 'Y' in MC6T)

MATH 1041. Calculus I. 4 Credit Hours.
This is a first semester calculus course primarily for students with some calculus background or strong precalculus skills. It involves both theory and applications. Students who earned a grade of C- in MATH 1022 must register for MATH 1039 simultaneously with MATH 1041. Students with no previous calculus experience or those needing extra review of precalculus topics are strongly encouraged to register for MATH 1039. Topics include functions, limits and continuity, differentiation of algebraic, trigonometric, exponential and logarithmic functions, curve sketching, optimization and L'Hospital's rule. NOTE: (1) Students may not get credit for more than one of MATH 1041 and MATH 1941. (2) This course can be used to satisfy the university Core Quantitative Reasoning B (QB) requirement or the GenEd Quantitative Literacy (GQ) requirement. However, this course is not appropriate for students whose sole purpose is to fulfill the quantitative core requirements. They should take MATH 1031 instead.

Course Attributes: QB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D (except where noted) in (MATH 1022 (C or higher), (MATH 1022 (C- or higher) and MATH 1039 (C or higher; may be taken concurrently)), MATH 1042, MATH 1044, MATH 1942, MATH 1951, 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, 'Y' in CRMA05, or 'Y' in MC6T)

MATH 1042. Calculus II. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This is a second semester calculus course that involves both theory and applications. Topics include the definite integral and the Fundamental Theorem of Calculus, applications of the definite integral, techniques of integration, improper integrals and sequences and series, including power and Taylor series.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1041, MATH 1941, MATH 1038, MATH 2043 (D or higher), 'Y' in MA06, 'Y' in MATW, 'Y' in CRMA08, or 'Y' in CRMA21)

MATH 1044. Introduction to Probability and Statistics for the Life Sciences. 4 Credit Hours.
A one-semester course at the freshman level to follow Calculus I for majors in Biology and Earth and Environmental Sciences (EES). Probabilistic and statistical methods needed for empirical modeling and associated data analysis, with examples primarily taken from the life sciences. This course does not serve as a prerequisite to Calculus III. Primarily for majors in Biology and EES.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 1041, MATH 1038, MATH 1941, MATH 1951, any MATH course numbered 2043 to 3080 (may be taken concurrently), 'Y' in MA06, or 'Y' in MATW)

MATH 1941. Honors Calculus I. 4 Credit Hours.
This course is typically offered in Fall and Spring.
This is a first semester calculus course that involves both theory and applications. Topics include functions, limits and continuity, differentiation of algebraic, trigonometric, exponential and logarithmic functions, curve sketching, optimization and L'Hospital's Rule. NOTE: This course can be used to satisfy the university Core Quantitative Reasoning B (QB) requirement or the GenEd Quantitative Literacy (GQ) requirement. However, this course is not appropriate for students whose sole purpose is to fulfill the quantitative core requirements. They should take Math 1031 instead.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO, QB

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of D (except where noted) in (MATH 1022 (C or higher), MATH 1042, MATH 1044, MATH 1942, MATH 1951, 'Y' in MC6, 'Y' in MA04, 'Y' in MC6A, 'Y' in MATW, 'Y' in CRMA05, or 'Y' in MC6T)

MATH 1942. Honors Calculus II. 4 Credit Hours.
This course is typically offered in Fall and Spring.
This is a second semester calculus course that involves both theory and applications. Topics include the definite integral and the Fundamental Theorem of Calculus, applications of the definite integral, techniques of integration, improper integrals and sequences and series, including power and Taylor series.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1041, MATH 1941, MATH 1038, MATH 2043 (D or higher), 'Y' in MA06, 'Y' in MATW, 'Y' in CRMA08, or 'Y' in CRMA21)

MATH 1951. Honors Accelerated Calculus I & II. 4 Credit Hours.
This course is typically offered in Fall.
This is a course for students who have had a year of calculus in high school. Its purpose is two-fold: to present a more theoretical treatment of calculus than is usually seen in an American high school and to prepare students for Math 2043, Calculus III. Topics covered will include some or all of the following: limits and continuity, derivatives and rules of differentiation, the Mean Value Theorem, L'Hospital's rule, optimization, graphing, the definite integral and the Fundamental Theorem of Calculus, u-substitution and integration by parts, limits of sequences, infinite series, convergence tests, power series, and Taylor series. NOTE: Prior to summer 2010, the course title was "Honors Differential & Integral Calculus."

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1041, MATH 1941, MATH 1038, 'Y' in MA06, 'Y' in MATW, 'Y' in CRMA08, or 'Y' in CRMA21) and (MATH 1042, MATH 1942, 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2021. Functions and Modeling. 3 Credit Hours.
This course is typically offered in Spring.
In this course, required for TUteach Mathematics with Teaching majors, students will give presentations and work in small groups to engage in explorations and lab activities designed to strengthen and expand their knowledge of the topics found in secondary mathematics; illuminate the connections between secondary and college mathematics and between various areas of mathematics; and illustrate productive uses of technology in teaching. Students will engage in non-routine problem solving, problem-based learning, and applications of mathematics. The course consists of four units: 1) Functions, 2) Modeling, 3) Overlooked Topics and Explorations, and 4) Geometry of Complex Numbers. Specific topics of investigation include function properties and patterns, complex numbers, parametric equations, polar equations, vectors, and exponential growth and decay. Explorations involve the use of multiple representations, transformations, data analysis techniques (such as curve fitting) and interconnections among topics in algebra, analytic geometry, statistics, trigonometry, and calculus. The lab investigations include use of various technologies including computers, calculators, and computer graphing software.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 1042, MATH 1951, or 'Y' in MATW) and (SCTC 1189, SCTC 1289, SCTC 1389, or MGRE 3111)

MATH 2031. Probability and Statistics. 3 Credit Hours.
This course is typically offered in Fall and Spring.
This course presents basic principles of statistical reasoning and the concepts from probability theory that give the student an understanding of the logic behind statistical techniques. Topics covered include rules of probability, discrete probability distributions, normal distribution, sampling distributions, the central limit theorem, point estimation, interval estimation, tests concerning means, tests based on count data, correlation and regression, and nonparametric statistics. NOTE: This course cannot be credited towards graduation if taken after Math 3031.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 1031, MATH 1041, MATH 1042, MATH 1044, MATH 1942, any MATH course numbered 2043 to 3080 (may be taken concurrently), STAT 1102, STAT 1902, or 'Y' in MATW)

MATH 2041. Differential Equations I. 3 Credit Hours.
This is a course in ordinary differential equations. Topics include first order ordinary differential equations, linear second order ordinary differential equations, systems of differential equations, numerical methods and the Laplace transform.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, 'Y' in MATW, 'Y' in MA07, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2043. Calculus III. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This is a third semester calculus course that involves both theory and applications. Topics include vectors in two or three dimensions, lines and planes in space, parametric equations, vector functions and their derivatives, functions of several variables, partial derivatives, multiple integrals, line integrals, and Green's, Divergence and Stokes' theorems.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, MATH 1951, 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2045. Differential Equations with Linear Algebra. 4 Credit Hours.
This course is typically offered in Fall.
This is a course in ordinary differential equations that emphasizes the use of linear algebra. It has two objectives: 1) to teach students how to solve linear differential equations and systems of linear differential equations, and 2) to introduce students to the linear algebra concepts such as vector spaces, dimension, basis, matrices, eigenvalues and eigenvectors, that play a key role in the theory of linear differential equations.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 2043 (may be taken concurrently), MATH 2943 (may be taken concurrently), 'Y' in MA08, 'Y' in CRMA12, or 'Y' in CRMA15)

MATH 2061. Euclidean Geometry. 3 Credit Hours.
This course is typically offered in Spring.
Students will be introduced to mathematical proofs and reasoning in the context of Euclidean geometry. The course will provide a foundation for more advanced courses in geometry and other proof-based mathematics courses.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1042, MATH 1942, MATH 1951, MATH 2043 (may be taken concurrently), any MATH course numbered 2100 to 3080 (C- or higher; may be taken concurrently), 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, 'Y' in CRMA11, or 'Y' in CRMA12)

MATH 2082. Sophomore Directed Study. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, Summer I, and Summer II.
Intensive study in a specific area. This course does not count for a mathematics related major elective credit. Prerequisites are MATH 1042 and a GPA of 3.5 or higher.

Repeatability: This course may not be repeated for additional credits.

MATH 2101. Linear Algebra. 3 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course covers vectors and vector spaces, matrices, determinants, systems of linear equations, linear transformations, inner products and orthogonality, and eigenvectors and eigenvalues. NOTE: Only one course, Math 2101 or Math 2103, can be credited towards graduation.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, MATH 1951, 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2103. Linear Algebra with Computer Lab. 4 Credit Hours.
This course is typically offered in Fall.
Topics in this course include: systems of linear equations; matrix algebra; determinants; fundamental subspaces; linear transformations; eigenvalues and eigenvectors; inner products; orthogonality; and spectral theory. Included is a computational lab component that uses activities and applications designed to promote understanding of the basic concepts from algebraic, symbolic, and geometric viewpoints. NOTE: Only one course, Math 2101 or Math 2103, can be credited towards graduation.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, MATH 1951, 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11) and MATH 1033.

MATH 2111. Basic Concepts of Math. 3 Credit Hours.
This course is typically offered in Fall, Spring, and Summer I.
This is a course designed to introduce students to mathematical abstraction and the language of mathematical proof. Topics include logic, sets, relations, integers, induction and modular arithmetic, functions, and cardinality. This course is highly recommended for students who have not been exposed to mathematical proof and intend to take advanced math courses.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1042, MATH 1942, MATH 1951, any MATH course numbered 2043 to 2110 (C- or higher; may be taken concurrently), any MATH course numbered 2112 to 3080 (C- or higher; may be taken concurrently), 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2121. Mathematical Modeling and Simulation. 3 Credit Hours.
This course exposes students to first-principles models of real-world processes, simulations on computers, and the proper interpretation of simulation results and data. The course focuses on applications in which first-principles modeling and simulation are not yet standard toolsets, such as: bacterial motion, disease spread, traffic flow, animal swarming/flocking/herding, crowd dynamics, ecology, economic markets, and social networks. However, the fundamental concepts and techniques apply equally to fields in which simulation is more commonplace, such as computational physics and engineering. In the course, students are provided with suitable software and high-level programming environments that enable them to engage right away in devising, modifying, and simulating models of interacting agents that describe real-world phenomena. In addition to homework problems that involve mathematical modeling and programming, the course also involves course projects, including final project reports and presentations.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1034, CIS 1051, CIS 1057, CIS 1068, CIS 1951, CIS 1968, 'Y' in CRCI01, 'Y' in CRCI04, 'Y' in CRCI05, or 'Y' in CRCI06) and (MATH 1042, MATH 1942, 'Y' in MATW, 'Y' in MA07, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2941. Honors Differential Equations I. 3 Credit Hours.
This course is typically offered in Fall and Spring.
This is a course in ordinary differential equations. Topics include first order ordinary differential equations, linear second order ordinary differential equations, systems of differential equations, numerical methods and the Laplace transform. Additional topics may include series solutions to differential equations, the matrix exponential, and various applications.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, 'Y' in MATW, 'Y' in MA07, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 2943. Honors Calculus III. 4 Credit Hours.
This course is typically offered in Fall and Spring.
This is a third semester calculus course that involves both theory and applications. Topics include vectors in two or three dimensions, lines and planes in space, parametric equations, vector functions and their derivatives, functions of several variables, partial derivatives, multiple integrals, line integrals, and Green's, Divergence and Stokes' theorems.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 1042, MATH 1942, MATH 1951, 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 3003. Theory of Numbers. 3 Credit Hours.
This course is typically offered in Fall and Spring.
Divisibility properties of integers, prime factorization, distribution of primes, linear and quadratic congruences, primitive roots, quadratic residues, quadratic reciprocity, simple Diophantine equations, cryptology.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 2111.

MATH 3031. Probability Theory I. 3 Credit Hours.
This course is typically offered in Fall and Spring.
Counting techniques, axiomatic definition of probability, conditional probability, independence of events, Bayes Theorem, random variables, discrete and continuous probability distributions, expected values, moments and moment generating functions, joint probability distributions, functions of random variables, covariance and correlation. NOTE: Prior to summer 2010, the course title was "Introduction to Probability Theory."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1042, MATH 1942, MATH 1951, MATH 2043 (C- or higher; may be taken concurrently), 'Y' in MA07, 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 3032. Mathematical Statistics. 3 Credit Hours.
This course is typically offered in Spring.
Random sampling, sampling distributions, Student's t, chi-squared and F distributions, unbiasedness, minimum variance unbiased estimators, confidence intervals, tests of hypothesis, Neyman-Pearson Lemma, and uniformly most powerful tests. NOTE: Prior to summer 2010, the course title was "Introduction to Mathematical Statistics."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3031 or AS 2101)

MATH 3041. Differential Equations I. 3 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This is a course in ordinary differential equations. Topics include first order ordinary differential equations, linear second order ordinary differential equations, systems of differential equations, numerical methods and the Laplace transform.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 2043 (may be taken concurrently)

MATH 3042. Differential Equations II. 4 Credit Hours.
This course is not offered every year.
This is a second course in differential equations. Topics include orthogonal polynomials, including Legendre and Chebyshev polynomials, Fourier series, partial differential equations, the boundary value problems and other topics of the instructor's choice. NOTE: This course is offered only in odd-numbered years.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3041 or MATH 3045)

MATH 3043. Numerical Analysis I. 4 Credit Hours.
This course is typically offered in Fall.
Computer arithmetic, pitfalls of computation, iterative methods for the solution of a single nonlinear equation, interpolation, least squares, numerical differentiation, numerical integration, and solutions of linear systems by direct and iterative methods.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 2043, (MATH 2101, MATH 2103, or MATH 2045), and (CIS 1053, CIS 1057, CIS 1068, or PHYS 2501)

MATH 3044. Numerical Analysis II. 3 Credit Hours.
This course is typically offered in Spring.
Solution of systems of nonlinear equations, solution of initial value problems, matrix norms and the analysis of iterative solutions, numerical solution of boundary value problems and partial differential equations, and introduction to the finite element method. NOTE: Offered in even-numbered years only.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 3043.

MATH 3045. Differential Equations with Linear Algebra. 4 Credit Hours.
This course is typically offered in Fall.
This is a course in ordinary differential equations that emphasizes the use of linear algebra. It has two objectives: 1) to teach students how to solve linear differential equations and systems of linear differential equations, and 2) to introduce students to the linear algebra concepts such as vector spaces, dimension, basis, matrices, eigenvalues and eigenvectors, that play a key role in the theory of linear differential equations.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 2043 (may be taken concurrently), 'Y' in MA08, or 'Y' in CRMA12)

MATH 3046. Differential Equations with Computer Lab. 4 Credit Hours.
This course is typically offered in Spring.
This course combines traditional material with a modern systems approach. It presents a thorough introduction to differential equations, tempering a classic "pure math" approach with more practical applied aspects. The course covers key topics such as first order equations, matrix algebra, systems, and phase plane portraits. The focus is on interpreting and solving problems through the use of software support and technology projects. Using software tools graphics will be used to display the ideas in ODEs; modeling and applications; and projects. An objective is to provide students with the opportunity to bring together much of what they have learned, including analytical, computational, and interpretative skills.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 2043 (may be taken concurrently), 'Y' in MA08, or 'Y' in CRMA12) and MATH 1033.

MATH 3051. Theoretical Linear Algebra. 4 Credit Hours.
This course is typically offered in Spring.
This is a course in linear algebra with a higher degree of abstraction than a traditional undergraduate linear algebra course. Topics include vector spaces, linear transformations, determinants, eigenvalues and eigenvectors, canonical forms, inner product spaces, and bilinear forms.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (MATH 2111 (C or higher) or 'Y' in CRMA14) and (MATH 3045, MATH 2045, MATH 2101, or MATH 2103)

MATH 3061. Modern Geometry I. 3 Credit Hours.
This course is typically offered in Fall.
An introduction to Euclidean and Noneuclidean geometries with a particular emphasis on theory and proofs.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2061 or MATH 2111) and (MATH 2045, MATH 2101, MATH 2103, or MATH 3051)

MATH 3082. Junior Individual Study. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, Summer I and Summer II.
Intensive study in a specific area. NOTE: May be taken in either semester.

Repeatability: This course may be repeated for additional credit.

MATH 3083. Junior Directed Reading. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, Summer I and Summer II.
Intensive study in a specific area. NOTE: May be taken in either semester.

Repeatability: This course may be repeated for additional credit.

MATH 3096. Introduction to Modern Algebra. 3 Credit Hours.
This course is typically offered in Fall and Spring.
This is a one-semester course in modern algebra that covers topics from group, ring, and field theory. Topics include groups and their basic properties, subgroups, normal subgroups and quotient groups, group homomorphisms, rings, rings of integers and polynomial rings, congruences in the rings of integers and polynomial rings, ideals and quotient rings, ring homomorphism, fields and field extensions, Galois theory.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 2111.

MATH 3098. Modern Algebra. 3 Credit Hours.
This course is typically offered in Fall.
This is the first semester in a year-long modern algebra sequence Math 3098 - Math 3101. It is a thorough introduction to the theory of groups and rings. NOTE: Students who have had limited exposure to proofs should consider taking Math 2111 first.

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 2111 or 'Y' in CRMA14) and (MATH 2101, MATH 2103, MATH 2045, MATH 3045 (C- or higher), 'Y' in MA09, 'Y' in MA10, or 'Y' in CRMA13)

MATH 3101. Topics in Modern Algebra. 3 Credit Hours.
This course is typically offered in Spring.
This is the second semester of a year-long modern algebra course. Topics come from theory of rings, fields and modules and from Galois theory.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 3098.

MATH 3137. Real & Complex Analysis I. 3 Credit Hours.
This course is typically offered in Fall.
Real and complex number systems, completeness. Sequences and series and their limits. Continuity of real and complex functions. Derivative. Analytic functions. Power series.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 2043, 'Y' in MA08, or 'Y' in CRMA12) and MATH 2111 (C- or higher)

MATH 3138. Real & Complex Analysis II. 3 Credit Hours.
This course is typically offered in Spring.
The Riemann-Stiltjes integral. Cauchy integral theorem. Cauchy integral formula and its consequences. The calculus of residues.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3137 or MATH 3141)

MATH 3141. Advanced Calculus I. 3 Credit Hours.
This course is typically offered in Fall.
This is a first semester course in real analysis. Topics include the real number system and the completeness property, sequences and their limits, limits of real-valued functions and continuity and point-set topology of Euclidean spaces. NOTE: Students who have had limited exposure to proofs should consider taking Math 2111 first.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (MATH 2043, 'Y' in CRMA12, or 'Y' in MA08), (MATH 2111, 'Y' in MA11, or 'Y' in CRMA14), and (MATH 2101, MATH 2103, MATH 2045, MATH 3045, 'Y' in MA09, 'Y' in MA10, or 'Y' in CRMA13)

MATH 3142. Advanced Calculus II. 3 Credit Hours.
This course is typically offered in Spring.
This is a second semester course in real analysis. Topics include the derivative and differentiable functions, the Riemann integral, infinite series and convergence tests, power and Taylor series and operations with them, and topics from calculus of several variables.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in MATH 3141.

MATH 3500. Topics in Contemporary Mathematics. 3 Credit Hours.
This course provides an in depth exposure to selected topics in advanced mathematics.

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 1042, MATH 1942, MATH 2043 (C- or higher; may be taken concurrently), MATH 2943 (C- or higher; may be taken concurrently), 'Y' in MATW, 'Y' in CRMA09, or 'Y' in CRMA11)

MATH 3941. Honors Differential Equations I. 3 Credit Hours.
This course is typically offered in Fall and Spring.
This is a course in ordinary differential equations. Topics include first order ordinary differential equations, linear second order ordinary differential equations, systems of differential equations, numerical methods and the Laplace transform. Additional topics may include series solutions to differential equations, the matrix exponential, and various applications.

Cohort Restrictions: Must be enrolled in one of the following Cohorts: SCHONORS, UHONORS, UHONORSTR.

Course Attributes: HO

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2043 (may be taken concurrently) or MATH 2943 (may be taken concurrently))

MATH 4001. History of Mathematics. 3 Credit Hours.
This course is not offered every year.
The development of the major mathematical concepts from ancient times to the present, emphasizing topics in the standard undergraduate curriculum. Special attention will be paid to the history of mathematics and mathematics education in the United States. NOTE: Offered in even-numbered years only.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in (any MATH course numbered 3001 to 4999 or 'Y' in CRMA20)

MATH 4003. Combinatorics. 3 Credit Hours.
This course is not offered every year.
Basic theorems and applications of combinatorial analysis, including generating functions, difference equations, Polya's theory of counting, graph theory, matching, and block diagrams. NOTE: Offered in odd-numbered years only.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2111, MATH 2196, or MATH 3003)

MATH 4033. Probability Theory II. 3 Credit Hours.
This course is typically offered in Fall.
Markov chains, exponential distribution, Poisson process, continuous time Markov chains, Brownian motion, stationary processes. NOTE: Prior to summer 2010, the course title was "Introduction to Probability Theory."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3031 or AS 2101) and (MATH 2101, MATH 3045, or MATH 2045)

MATH 4041. Partial Differential Equations. 3 Credit Hours.
This course is typically offered in Spring.
The solution and properties of first and second order equations; heat and wave equation. Elliptic boundary value problems and Green's functions. Hyperbolic problems and the theory of characteristics. Finite difference methods. The equations of mathematical physics.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2101, MATH 2103, or MATH 3051) and (MATH 2041, MATH 2045, MATH 3041, or MATH 3045)

MATH 4043. Applied Mathematics. 3 Credit Hours.
This course is typically offered in Fall.
The construction and study of mathematical models for physical, economic, and social processes. NOTE: Offered in odd-numbered years only.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 2045, MATH 3045, or Completed the following: (MATH 2101, MATH 2103, or MATH 3051) and (MATH 2041, MATH 3041, or MATH 3046))

MATH 4051. Complex Analysis. 3 Credit Hours.
This course is typically offered in Fall.
Complex numbers, analytic functions, harmonic functions, power and Laurent series, Cauchy's theorem, calculus of residues, and conformal mappings. NOTE: Prior to summer 2010, the course title was "Introduction to Functions of a Complex Variable."

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C (except where noted) in (MATH 3138, MATH 3142 (C- or higher), 'Y' in MA12, or 'Y' in CRMA17)

MATH 4061. Differential Geometry. 3 Credit Hours.
This course is typically offered in Spring of even years.
This course is an introduction to differential geometry starting with concepts learned in Calculus III. A particular emphasis will be placed on the study of curves and surfaces in 3-space and their generalizations. The course will revolve around Riemannian geometry, but, time permitting, it will also include a brief introduction to one or more of the following: symplectic geometry and its relation to classical mechanics, general connections and their relation with field theory and pseudoriemannian manifolds, and general relativity.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- (except where noted) in (MATH 2043 (C or higher), 'Y' in MA08, or 'Y' in CRMA12) and (MATH 2045, MATH 2101, MATH 2103, or MATH 3051)

MATH 4063. Topology I. 3 Credit Hours.
This course is typically offered in Spring of odd years.
Topological and metric spaces. Continuity, compactness, connectedness, convergence. Introduction to algebraic and combinatorial topology. Classification of compact surfaces, fundamental groups and covering spaces.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3137 or MATH 3141) and (MATH 3096 or MATH 3098)

MATH 4082. Senior Individual Study. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, Summer I and Summer II.
Intensive individual study at a senior or graduate level. Arranged each semester. Please consult with the instructor. NOTE: Can be taken in either semester.

Repeatability: This course may be repeated for additional credit.

MATH 4083. Senior Directed Reading. 1 to 4 Credit Hour.
This course is typically offered in Fall, Spring, Summer I and Summer II.
Intensive individual study at a senior or graduate level. Arranged each semester. Please consult with the instructor. NOTE: Can be taken in either semester.

Repeatability: This course may be repeated for additional credit.

MATH 4096. Senior Problem Solving. 3 Credit Hours.
This course is typically offered in Fall and Spring.
This is a course in mathematical discovery through problem solving. Students will be expected to develop two or three areas of mathematics by solving problems, assigned by the instructor. Problems will be solved both individually and in groups. (Capstone writing course.)

Course Attributes: WI

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C- in (MATH 3138 (may be taken concurrently), MATH 3142 (may be taken concurrently), or MATH 3044 (may be taken concurrently)) and (MATH 3051, MATH 3096, or MATH 3098)

MATH 5000. Special Topics in Math. 3 Credit Hours.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 5001. Linear Algebra. 3 Credit Hours.
Vector spaces and subspaces over the real and complex numbers; linear independence and bases; linear mappings; dual and quotient spaces; fields and general vector spaces; polynomials, ideals and factorization of polynomials; determinant; Jordan canonical form. Fundamentals of multilinear algebra.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5003. Professional Development Seminar. 1 Credit Hour.
This class advances intentional Professional Development by creating an online professional profile and portfolio that allows employers to determine the strength of a student's candidacy for a specific job. Students develop an online professional profile, attend a Professional Development Workshop and write a White paper which demonstrates analytical and technical writing skills on a topic of interest to the student. The White Paper proposes a change in any STEM area where a lack of efficiency in a process, or gap in knowledge, in an area of research, exists. Finally, students organize a networking event by inviting speakers, hiring managers and graduate students in CST.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Degree Restrictions: Must be enrolled in one of the following Degrees: Prof Science Masters.
College Restrictions: Must be enrolled in one of the following Colleges: Science & Technology.

Repeatability: This course may not be repeated for additional credits.

MATH 5005. Ethics in Computing. 2 Credit Hours.
This course will examine the social, legal, and privacy issues applying to scientific data. Students will be given the opportunity to discuss contemporary case studies, in addition to NIH-sanctioned online training modules (Responsible Conduct in Research). The case-study based approach used in class will expose students to ethics of database management and security, open-access and open-source philosophies, the ethics of collecting, storing, and disseminating data.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Degree Restrictions: Must be enrolled in one of the following Degrees: Prof Science Masters.
College Restrictions: Must be enrolled in one of the following Colleges: Science & Technology.

Repeatability: This course may not be repeated for additional credits.

MATH 5007. Combinatorics. 3 Credit Hours.
Basic theorems and applications of combinatorial analysis, including generating functions, difference equations, Polya's theory of counting, graph theory, matching, and block diagrams.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5011. Algebra and Functions for Teaching. 3 Credit Hours.
This class will broaden and deepen our understanding of algebra and functions and their many applications. We will begin with an examination of the concept of function generally and then look at examples. We will consider the usefulness of functions, both in modeling real phenomena and in solving equations. We will carefully develop more advanced concepts from basic principles and logic as we proceed from polynomial functions to rational, radical, exponential, logarithmic, and trigonometric functions. As we do this, we will explore non-traditional teaching techniques and tools such as the practice of inquiry-based learning and the appropriate use of technology. We will also utilize and discuss the eight Mathematical Practice Standards set forth in the Common Core State Standards.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 1042.

MATH 5012. Introduction to Mathematical Modeling for Teaching. 3 Credit Hours.
In this course, mathematics will be discussed as the language of science. Many students do not have an adequate picture of mathematics: they see it either as a dry formal list of formulas or a dull study of numbers. Mathematics is in fact a network of intriguing and profound ideas that are deeply connected to reality. As a language, mathematics provides penetrating techniques of thought that allow us to analyze physical reality and to look for answers or solutions to some of the most intriguing real-life questions. Students will be asked to read the material in advance and come prepared for class discussion. The in-class activities will be conducted in an inquiry-minded fashion.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 1042.

MATH 5013. Geometry for Teaching. 3 Credit Hours.
This class will provide a deep and complete picture of the underlying concepts needed to teach high school geometry. We'll start by learning about the basic axiomatic method, which is fundamental to all of mathematics. We'll learn about the rigid transformations (reflections, rotations, and translations) and the important role that they can play in defining congruence more generally. We'll finish by looking at some important examples of non-Euclidean geometry, where Euclid's famous parallel postulate does not hold.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 1042.

MATH 5014. Probability Theory and Applications for Teaching. 3 Credit Hours.
Probability is a fundamental topic with applications in nearly every aspect of life. The goal for this course is to equip the student with a large and diverse set of tools with which to tackle a wide variety of problems, both theory and application based. We will focus on the ideas behind the important topics e.g. conditioning, averages, binomial distribution, and explain their origins and applications. This will equip the student to teach their own students this material with an emphasis on the "why", which is essential to maintaining attentiveness.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 1042.

MATH 5015. Modern Algebra for Teaching. 3 Credit Hours.
Students will understand the integers and polynomial rings over a field as being specific examples of rings. The idea of quotient spaces will be emphasized with the particular examples of the integers modulo n and factor rings of polynomial rings illustrating and introducing the concept. Moreover, the ability to read and to construct well-written and correct mathematical proofs on these topics is an overarching goal of the course. Written communication skills will also be emphasized.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 2111.

MATH 5016. Mathematical Analysis for Teaching. 3 Credit Hours.
This course will start with a discussion of the basic topology of the real line and the creation of the basic tools using the completeness axiom. From there, the course will proceed to sequences and series, limits, continuity, differentiation, Riemann integration, and Taylor series representations of functions.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 2043.

MATH 5017. Number Theory and Proof for Teaching. 3 Credit Hours.
In this course, we encounter and explore fundamental ideas in number theory. Basic properties of the integers and their two principal operations, addition and multiplication, will form the starting point of our study. Along the way, the course will introduce some basic logic and the rigorous notion of mathematical proof, including mathematical induction, in the context of number theory. Through this elementary foundation, students will experience the richness of mathematics: proof going back as far as Euclid, examples of elementary yet still unproven conjectures, and results that are easy to state and understand but require extremely complicated proofs.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of C in MATH 1042.

MATH 5033. Introduction to Stochastic Processes. 3 Credit Hours.
This course is typically offered in the Fall.
Markov chains, exponential distribution, Poisson process, continuous time Markov chains, Brownian motion, stationary processes.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5041. Concepts of Analysis I. 3 Credit Hours.
Advanced calculus in one and several real variables. Topics include topology of metric spaces, continuity, sequences and series of numbers and functions, convergence, including uniform convergence. Ascoli and Stone-Weierstrass theorems. Integration and Fourier series. Inverse and implicit function theorems, differential forms, Stokes theorem.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5042. Concepts of Analysis II. 3 Credit Hours.
Advanced calculus in one and several real variables. Topics include topology of metric spaces, continuity, sequences and series of numbers and functions, convergence, including uniform convergence. Ascoli and Stone-Weierstrass theorems. Integration and Fourier series. Inverse and implicit function theorems, differential forms, Stokes theorem.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 5041.

MATH 5043. Introduction to Numerical Analysis. 3 Credit Hours.
Roots of nonlinear equations, errors, their source and propagation, linear systems, approximation and interpolation of functions, numerical integration.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5044. Introduction to Numerical Analysis II. 3 Credit Hours.
This course will cover the following topics: Analysis and numerical solutions of ordinary differential equations, Runge-Kutta, multistep, and Taylor series methods; deferred correction; convergence and stability; stiff problems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5045. Ordinary Differential Equations. 3 Credit Hours.
Existence and uniqueness theorems, continuous and smooth dependence on parameters, linear differential equations, asymptotic behavior of solutions, isolated singularities, nonlinear equations, Sturm-Liouville problems, numerical solution of ODEs.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5057. Introduction to Methods in Applied Mathematics I. 3 Credit Hours.
This is the first semester of a two-semester general overview of mathematical concepts and tools for applied mathematics. Topics to be covered include modeling and derivation of equations of continuum mechanics; solution methods for linear PDE in special domains, such as Fourier and Laplace transforms as well as Green's functions; calculus of variations and control theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5058. Introduction to Methods in Applied Mathematics II. 3 Credit Hours.
This is the second semester of a two-semester general overview of mathematical concepts and tools for applied mathematics. Topics to be covered include dynamical systems and bifurcation theory; asymptotic analysis and perturbation theory; systems of hyperbolic conservation laws. Material is largely independent of MATH 5057.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5061. Fundamentals of Computer Programming for Scientists and Engineers. 4 Credit Hours.
Scientists and engineers use computers for a multitude of purposes. Even with ready-to-use applications, some amount of computer programming is commonly required to adapt to changing technology while attaining the rigorous standards of each specific discipline. This course focuses on fundamental computer programming constructs, introducing the languages Python, C++ and Fortran. Through lectures and intensive exercises students will learn to implement fundamental mathematical constructs and solve basic programming problems relevant to scientific applications. The course briefly reviews also the Linux environment, its software development tools and language interoperability. For each programming language, the course focuses on constructs and syntax designed for performance and numerical accuracy, in connection with methods from applied science, mathematics and engineering. The students taking the course are expected to have sufficient mathematical maturity, as evidenced, for example, by having completed an undergraduate Calculus sequence. The majority of the grade is determined by a mid-term and a final exam, both including a combination of questionnaires and supervised programming assignments.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5062. High Performance Computer Programming for Scientific Modeling. 3 Credit Hours.
This course will provide theory and hands-on experience programming high performance computers for the solution of scientific modeling problems. This includes in particular problems arising from the discretizations of differential equations. Topics covered include domain decomposition and mesh partitioning, quantifying the computation and communication cost, communication avoidance methods, Monte Carlo methods, multithreading, benchmarking and optimization of the parallel computations.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 5061.

MATH 5063. Introduction to High-Performance Computing Technology for Scientists. 4 Credit Hours.
This course is an introduction to the technology used in Linux clusters and supercomputers dedicated to calculations in applied science and engineering. The basic architecture of modern computers (processing units, memory, storage, operating system) is briefly reviewed, emphasizing the role and performance impact of each element in numerical computation. The core of the course focuses on setup and management of computer hardware specialized for scientific computing, and on its impact on commonly used strategies and methods for scientific computation. The material is organized in a combination of lectures and hands-on exercises, using computer hardware hosted at local facilities as well as virtualized resources. The majority of the grade is determined by a mid-term and a final exam, both including a combination of questionnaires and identification of the most efficient solution to common numerical problems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 5061 (may be taken concurrently)

MATH 5065. Topology. 3 Credit Hours.
Topological and metric spaces. Continuity, compactness, connectedness, convergence. Introduction to algebraic and combinatorial topology. Classification of compact surfaces, fundamental groups and covering spaces.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5066. Mathematical Methods for High Performance Computing. 3 Credit Hours.
This course presents mathematical methods for the solution of a variety of discrete and algebraic problems which are at the core of many scientific and engineering applications. The methods covered are especially tailored for high performance computing. Topics include large matrix computations, graphs and networks, fast Fourier transforms, geometric and algebraic multi-grid methods, and constrained optimization.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 5061, MATH 5062, and MATH 5063.

MATH 5067. Introduction to Abstract Algebra I. 3 Credit Hours.
This is the first semester in a year-long abstract algebra sequence MATH 5067 - MATH 5068. It is a thorough introduction to the theory of groups and rings.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 5068. Introduction to Abstract Algebra II. 3 Credit Hours.
This is the second semester of a year-long abstract algebra course. Topics come from theory of rings, fields and modules and from Galois theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8001. Candidates Seminar. 1 to 3 Credit Hour.
Challenging problems from many different areas of mathematics are posed and discussed.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8002. Candidates Seminar. 1 to 3 Credit Hour.
Challenging problems from many different areas of mathematics are posed and discussed.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8003. Number Theory. 3 Credit Hours.
This is an introduction to the ideas and techniques of number theory, elementary, analytic, and algebraic. The object of the course is to demonstrate how real and complex analysis and modern algebra can be applied to classical problems in number theory. References: H. Rademacher, "Lectures on elementary number theory"; H. Davenport, "Multiplicative number theory"; Rosen and Ireland, "A classical introduction to algebraic number theory."

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8004. Number Theory. 3 Credit Hours.
This is an introduction to the ideas and techniques of number theory, elementary, analytic, and algebraic. The object of the course is to demonstrate how real and complex analysis and modern algebra can be applied to classical problems in number theory. References: H. Rademacher, "Lectures on elementary number theory"; H. Davenport, "Multiplicative number theory"; Rosen and Ireland, "A classical introduction to algebraic number theory."

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8011. Abstract Algebra I. 3 Credit Hours.
Groups, rings, modules, fields; Galois theory; linear algebra.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8012. Abstract Algebra II. 3 Credit Hours.
Groups, rings, modules, fields; Galois theory; linear algebra.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8011.

MATH 8013. Numerical Linear Algebra I. 3 Credit Hours.
The syllabus includes iterative methods, classical methods, nonnegative matrices. Semi-iterative methods. Multigrid methods. Conjugate gradient methods. Preconditioning. Domain decomposition. Direct Methods. Sparse Matrix techniques. Graph theory. Eigenvalue Problems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8014. Numerical Linear Algebra II. 3 Credit Hours.
The syllabus includes iterative methods, classical methods, nonnegative matrices. Semi-iterative methods. Multigrid methods. Conjugate gradient methods. Preconditioning. Domain decomposition. Direct Methods. Sparse Matrix techniques. Graph theory. Eigenvalue Problems.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8013.

MATH 8023. Numerical Differential Equations I. 3 Credit Hours.
Analysis and numerical solution of ordinary and partial differential equations. Elliptic, parabolic and hyperbolic systems. Constant and variable coefficients. Finite difference methods. Finite element methods. Convergence analysis. Practical applications.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8024. Numerical Differential Equations II. 3 Credit Hours.
Analysis and numerical solution of ordinary and partial differential equations. Elliptic, parabolic and hyperbolic systems. Constant and variable coefficients. Finite difference methods. Finite element methods. Convergence analysis. Practical applications.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8023.

MATH 8031. Probability Theory. 3 Credit Hours.
With a rigorous approach the course covers the axioms, random variables, expectation and variance. Limit theorems are developed through characteristic functions.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8032. Stochastic Processes. 3 Credit Hours.
Random sequences and functions; linear theory; limit theorems; Markov processes; branching processes; queuing processes.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8031.

MATH 8041. Real Analysis I. 3 Credit Hours.
The syllabus coincides with the syllabus for the Ph.D. Examination in Real Analysis.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8042. Real Analysis II. 3 Credit Hours.
The syllabus coincides with the syllabus for the Ph.D. Examination in Real Analysis.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8041.

MATH 8051. Functions of a Complex Variable I. 3 Credit Hours.
Analytic functions. Conformal mapping. Analytic continuation. Topics in univalent functions, elliptic functions, Riemann surfaces, analytic number theory. Nevanlinna theory, several complex variables.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8052. Functions of a Complex Variable II. 3 Credit Hours.
Analytic functions. Conformal mapping. Analytic continuation. Topics in univalent functions, elliptic functions, Riemann surfaces, analytic number theory. Nevanlinna theory, several complex variables.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8051.

MATH 8061. Differential Geometry and Topology I. 3 Credit Hours.
Elementary theory of smooth manifolds. Singular cohomology and DeRham's theorem. Fundamental group and covering spaces. Hodge theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8062. Differential Geometry and Topology II. 3 Credit Hours.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8061.

MATH 8107. Mathematical Modeling for Science, Engineering, and Industry. 3 Credit Hours.
In this course, students work in groups on projects that arise in industry, engineering, or in other disciplines of science. In addition to being advised by the course instructors, in all projects an external partner is present. The problems are formulated in non-mathematical language, and the final results need to be formulated in a language accessible to the external partner. This means in particular that the mathematical and computational methods must be selected or created by the students themselves. Students disseminate their progress and achievements in weekly presentations, a mid-term and a final project report, and a final presentation. Group work with and without the instructors' involvement is a crucial component in this course.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8007 and MATH 8008.

MATH 8141. Partial Differential Equations I. 3 Credit Hours.
The classical theory of partial differential equations. Elliptic, parabolic, and hyperbolic operations.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8142. Partial Differential Equations II. 3 Credit Hours.
The classical theory of partial differential equations. Elliptic, parabolic, and hyperbolic operations.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8141.

MATH 8161. Topology. 3 Credit Hours.
Point set topology through the Urysohn Metrization Theorem; fundamental group and covering spaces. Differential forms; the DeRham groups.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 5041.

MATH 8200. Topics in Applied Mathematics. 3 Credit Hours.
Variable topics, such as control theory and transform theory, will be treated.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8210. Topics in Applied Mathematics II. 3 Credit Hours.
Variable topics, such as control theory and transform theory, will be treated.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8700. Topics Computer Program. 3 Credit Hours.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8710. Topics Computer Program. 3 Credit Hours.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 8981. Graduate Development Seminar. 1 Credit Hour.
This course aims to familiarize first-year PhD students with the structure of a PhD in Mathematics. A significant focus of the course is professional development, wherein students learn about important milestones in the program and are trained in the related responsibilities. Students enrolled in this course must attend at least one seminar or colloquium per week, in order to be exposed to research-level mathematics and best practices for communicating mathematics. The seminar itself features a weekly discussion on a topic of interest, led by the Director of Graduate Studies and/or a senior TA. Topics covered in the seminar should include: Basics of departmental structure; effective study techniques for graduate courses and qualifying exams; best practices for professional conduct; creating a professional webpage; written and oral communication of research-level mathematics; research topics studied by faculty in the department; the process of finding a PhD advisor, e.g. through independent study courses; organizing PhD studies with perspective of post-PhD career goals; finding and applying for summer internships in industry and education; and applying for post-PhD employment, in and out of academia.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 8985. Teaching in Higher Education. 1 to 3 Credit Hour.
This course is required for any student seeking Temple's Teaching in Higher Education Certificate. The course focuses on the research on learning theory and the best teaching practices, with the aim of preparing students for effective higher education teaching. All educational topics will be considered through the lens of teaching mathematics and quantitative thinking.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9000. Topics in Number Theory I. 3 Credit Hours.
Analytic and algebraic number theory. Classical results and methods and special topics such as partition theory, asymptotic, Zeta functions, transcendence, modular functions.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9003. Modular Functions. 3 Credit Hours.
This course focuses upon the modular group and its subgroups, the corresponding fundamental region and their invariant functions. Included will be a discussion of the basic properties of modular forms and their construction by means of Eisenstein and Poincar © series and theta series. Other topics: the Hecke correspondence between modular forms and Dirichlet series with functional equations, the Peterson inner product, the Hecke's operators. Emphasis will be placed upon applications to number theory. References: M. Knopp, "Modular functions in analytic number theory"; J. Lehner, "A short course in automorphic forms"; B. Schoeneberg, "Elliptic modular forms."

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9004. Modular Functions. 3 Credit Hours.
This course focuses upon the modular group and its subgroups, the corresponding fundamental region and their invariant functions. Included will be a discussion of the basic properties of modular forms and their construction by means of Eisenstein and Poincar © series and theta series. Other topics: the Hecke correspondence between modular forms and Dirichlet series with functional equations, the Peterson inner product, the Hecke's operators. Emphasis will be placed upon applications to number theory. References: M. Knopp, "Modular functions in analytic number theory"; J. Lehner, "A short course in automorphic forms"; B. Schoeneberg, "Elliptic modular forms."

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9005. Combinatorial Mathematics. 3 Credit Hours.
Topics include: Enumeration, Trees, Graphs, Codes, Matchings, Designs, Chromatic Polynomials, Coloring, Networks.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9010. Topics in Number Theory II. 3 Credit Hours.
Analytic and algebraic number theory. Classical results and methods and special topics such as partition theory, asymptotic, Zeta functions, transcendence, modular functions.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9011. Homological Algebra. 3 Credit Hours.
Students will learn fundamental notions of homological algebra such as chain complexes, Abelian categories, derived functors, and spectral sequences. A portion of this course is also devoted to rudiments of category theory. Students will learn how to apply constructions of homological algebra and category theory to questions from abstract algebra, topology and deformation theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8011 and MATH 8012.

MATH 9012. Representation Theory I. 3 Credit Hours.
This is the first semester of a two-semester course on the principal methods and results of algebraic representation theory. The course will start with an introduction to the fundamental notions, tools and general results of representation theory in the setting of associative algebras. This will be followed by a thorough coverage of the classical representation theory of finite groups over an algebraically closed field of characteristic zero. If time permits, then the semester will conclude with a brief introductory discussion of the representation theory of the general linear group.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8011 and MATH 8012.

MATH 9013. Representation Theory II. 3 Credit Hours.
This is the second part of a two-semester course sequence on the principal methods and results of algebraic representation theory. The main focus will be on representations of finite-dimensional Lie algebras, with particular emphasis on the case of semisimple Lie algebras. Time permitting, the course will conclude with an introduction to the representation theory of Hopf algebras.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 9012.

MATH 9014. Commutative Algebra and Algebraic Geometry I. 3 Credit Hours.
This is the first semester of a two-semester course on the fundamental concepts of commutative algebra and classical as well as modern algebraic geometry. Topics for the first semester include: ideals of commutative rings, modules, Noetherian and Artinian rings, Noether normalization, Hilbert's Nullstellensatz, rings of fractions, primary decomposition, discrete valuation rings and the rudiments of dimension theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8011 and MATH 8012.

MATH 9015. Commutative Algebra and Algebraic Geometry II. 3 Credit Hours.
This is the second semester of a two-semester course on the fundamental concepts of commutative algebra and classical as well as modern algebraic geometry. Topics for the second semester include: affine and projective varieties, morphisms of algebraic varieties, birational equivalence, and basic intersection theory. In the second semester, students will also learn about schemes, morphisms of schemes, coherent sheaves, and divisors.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 9014.

MATH 9021. Riemannian Geometry. 3 Credit Hours.
The main goal of this one-semester course is to provide a solid introduction to the two central concepts of Riemannian Geometry, namely, geodesics and curvature and their relationship. After taking this course, students will have an intimate acquaintance with the tools and concepts that are needed for pursuing research in Riemannian Geometry or applying its ideas to other fields of mathematics such as analysis, topology, and algebraic geometry. The topics covered include Riemannian metrics, Riemannian connections, geodesics, curvature (sectional, Ricci, and scalar curvatures), the Jacobi equation, the second fundamental form, and global results such as the Gauss-Bonnet Theorem, the theorems of Hopf-Rinow and Hadamard, variations of energy, the theorems of Bonnet-Myers and of Synge-Weinstein, and the Rauch comparison theorem.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8061 and MATH 8062 (may be taken concurrently)

MATH 9023. Knot Theory and Low-Dimensional Topology I. 3 Credit Hours.
This is the first semester of a year-long course surveying the modern theory of knots and providing an introduction to some fundamental results and techniques of low-dimensional topology. The course will start at the very beginning of knot theory; it will then proceed to several classical knot invariants (Alexander, Jones, HOMFLY polynomials). The first semester will also touch on braid groups and mapping class groups, and use these groups to show that every (closed, orientable) 3-manifold can be constructed via knots.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8061 and MATH 8062.

MATH 9024. Knot Theory and Low-Dimensional Topology II. 3 Credit Hours.
This is the second semester of a year-long course surveying the modern theory of knots and providing an introduction to some fundamental results and techniques of low-dimensional topology. This course will continue the development of knot invariants begun during the first semester, in particular exploring the connection between knots and braid groups. It will also use Dehn surgery techniques to extend construct quantum invariants of closed 3-dimensional manifolds. Finally, the course will survey several results in 4-dimensional topology and their connection to knot theory.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 9023.

MATH 9031. Advanced Probability Theory. 3 Credit Hours.
This course is a continuation of MATH 8031 and is based on measure theory. It covers advanced topics in probability theory: martingales, Brownian motion, Markov chains, continuous time Markov processes, ergodic theory and their applications.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9041. Functional Analysis I. 3 Credit Hours.
Topics covered include Banach and Hilbert spaces, Banach-Steinhaus theorem, Hahn-Banach theorem, Stone-Weierstrass theorem, Operator theory, self-adjointness, compactness. Also covered are Sobolev spaces, embedding theorems, Schwartz distributions, Paley-Wiener theory. If time permits, Banach and C algebras will be covered.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8041 and MATH 8042.

MATH 9042. Functional Analysis II. 3 Credit Hours.
Topics covered include: Banach and Hilbert spaces, Banach-Steinhaus theorem, Hahn-Banach theorem, Stone-Weierstrass theorem, Operator theory, self-adjointness, compactness. Also covered are Sobolev spaces, embedding theorems, Schwartz distributions, Paley-Wiener theory. If time permits, Banach and C algebras will be covered.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 9041.

MATH 9043. Calculus of Variations. 3 Credit Hours.
First variation and Euler-Lagrange equations. Null-Lagrangians and the Caratheodory's "Royal Road". Geodesic coverings, the eikonal and the Hamilton-Jacobi equation. Second variation and Jacobi's theory of conjugate points. Strong variations and Weierstrass E-function. Hamiltonian formalism and convex duality. Hilbert's invariant integral.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9044. Harmonic Analysis. 3 Credit Hours.
A year long course to explore the real-variable techniques developed in Harmonic Analysis to study smoothness properties of functions and the behavior of certain spaces under the action of some operators. These techniques are also essential in many applications to PDE's and several complex variables. Offered every two years.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9051. Several Complex Variables I. 3 Credit Hours.
Holomorphic functions of several complex variables, domains of holomorphy, pseudoconvexity, analytic varieties, CR manifolds.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8051 and MATH 8052.

MATH 9052. Several Complex Variables II. 3 Credit Hours.
Holomorphic functions of several complex variables, domains of holomorphy, pseudoconvexity, analytic varieties, CR manifolds.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 9051.

MATH 9053. Harmonic Analysis. 3 Credit Hours.
A year long course to explore the real-variable techniques developed in Harmonic Analysis to study smoothness properties of functions and the behavior of certain spaces under the action of some operators. These techniques are also essential in many applications to PDE's and several complex variables. Offered every two years.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9061. Lie Groups. 3 Credit Hours.
This course develops Lie theory from the ground up. Starting with basic definitions of Lie group-manifolds and Lie algebras, the course develops structure theory, analytic and algebraic aspects, and representation theory. Interactions with other fields, e.g., differential equations and geometry are also discussed.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9062. Lie Groups. 3 Credit Hours.
This course develops Lie theory from the ground up. Starting with basic definitions of Lie group-manifolds and Lie algebras, the course develops structure theory, analytic and algebraic aspects, and representation theory. Interactions with other fields, e.g., differential equations and geometry are also discussed.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9063. Riemann Surfaces. 3 Credit Hours.
Introduction to differential geometry, Riemannian manifolds and Hodge theory; classification of complex structures of oriented two-manifolds as conformal classes of Riemannian metrics; covering spaces and the uniformization theorem; the moduli space of the torus; the Riemann-Roch theorem for compact Riemann surfaces; interpretation of the Riemann-Roch theorem as the index of an elliptic operator.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9064. Riemann Surfaces. 3 Credit Hours.
Moduli and Teichmueller spaces for compact Riemann surfaces; introduction to modular forms; embedding of compact Riemann surfaces in complex projective spaces. Branched coverings and maps onto the Riemann sphere.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9071. Differential Topology. 3 Credit Hours.
Moduli and Teichmueller spaces for compact Riemann surfaces; introduction to modular forms; embedding of compact Riemann surfaces in complex projective spaces. Branched coverings and maps onto the Riemann sphere.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9072. Differential Topology. 3 Credit Hours.
Topics and emphasis may vary depending on instructor and may include surgery, handlebodies, cobordism; topological manifolds with smooth structure, manifolds with more than one smooth structures; topology of vector bundles, characteristic classes, index theorem.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

MATH 9073. Geometric Group Theory. 3 Credit Hours.
This semester-long course will survey the rapidly expanding field of geometric group theory, focusing on the role played by negative curvature. We will begin with classical combinatorial techniques used to construct and study infinite discrete groups. After introducing basic concepts in coarse geometry, we will turn our attention to Gromov's notion of hyperbolic groups. In addition to studying geometric, algebraic, and algorithmic properties of these groups, we will keep an eye towards several generalizations of hyperbolicity that have recently played a large role in understanding many geometrically significant groups. As examples, we will also touch on the study of mapping class groups, outer automorphism groups of free groups, and cubical groups.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may not be repeated for additional credits.

Pre-requisites: Minimum grade of B- in MATH 8061 and MATH 8062.

MATH 9082. Independent Study. 1 to 3 Credit Hour.
Independent research supervised by a Mathematics faculty member.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9083. Independent Study. 1 to 3 Credit Hour.
Independent research supervised by a Mathematics faculty member.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9100. Topics in Algebra. 3 Credit Hours.
Variable topics in theory of commutative and non-commutative rings, groups, algebraic number theory, algebraic geometry.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9110. Topics in Algebra. 3 Credit Hours.
Variable topics in theory of commutative and non-commutative rings, groups, algebraic number theory, algebraic geometry.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9120. Seminar in Algebra. 3 Credit Hours.
The seminar aims to lead participating students up to the frontier of current research in algebra. The typical formats are single lectures or short series of lectures by students or the instructor on various topics in algebra, including noncommutative algebra, representation theory, group theory, operads and connections to mathematical physics. Occasionally, slightly longer mini-courses are presented in the framework of the seminar or an entire semester is devoted to a single topic of particular interest.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9200. Topics in Numerical Analysis. 3 Credit Hours.
These courses cover some basic, as well as advanced topics in numerical analysis. The topics can be changed from time to time. The usual topics include: scientific computing, numerical methods for differential equations, computational fluid dynamics, Monte Carlo simulation, Optimization, Spare matrices, Fast Fourier transform and applications, etc.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9210. Topics in Numerical Analysis. 3 Credit Hours.
These courses cover some basic, as well as advanced topics in numerical analysis. The topics can be changed from time to time. The usual topics include: scientific computing, numerical methods for differential equations, computational fluid dynamics, Monte Carlo simulation, Optimization, Spare matrices, Fast Fourier transform and applications, etc.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9300. Seminar in Probability. 3 Credit Hours.
Research topics related to probability theory are presented in the seminar. Topics vary depending on the interests of the students and the instructor. Current topics include stochastic calculus with applications in mathematical finance, statistical mechanics, interacting particle systems, percolation, and probability models in mathematical physics.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9310. Seminar in Probability. 3 Credit Hours.
Research topics related to probability theory are presented in the seminar. Topics vary depending on the interests of the students and the instructor. Current topics include stochastic calculus with applications in mathematical finance, statistical mechanics, interacting particle systems, percolation, and probability models in mathematical physics.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9400. Topics in Analysis. 3 Credit Hours.
Variable content course.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9410. Topics in Functional Analysis. 3 Credit Hours.
This is a year-long sequence. The content varies from time to time depending on the interests of the students. Typical topics include some of the following: pseudodifferential operators, Fourier integral operators, singular integral operators, applications to partial differential equations.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9420. Topics in Differential Equations II. 3 Credit Hours.
This is a year-long sequence. Topics covered may include the theory of elliptic partial differential equations in divergence form and non-divergence form, and nonlinear PDEs. These courses may also focus on pseudodifferential operators and Fourier integral operators.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9500. Topics in Differential Geometry and Topology I. 3 Credit Hours.
Variable topics in geometric topology and related areas. Topics include: surfaces and their diffeomorphisms, mapping class groups, braids, 3-dimensional manifolds, geometric structures on manifolds, and group actions on geometric objects.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of B- in MATH 8061 and MATH 8062.

MATH 9510. Topics in Differential Geometry and Topology II. 3 Credit Hours.
Variable topics in geometric topology and related areas. Topics include: surfaces and their diffeomorphisms, mapping class groups, braids, 3-dimensional manifolds, geometric structures on manifolds, and group actions on geometric objects.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

Pre-requisites: Minimum grade of B- in MATH 8061 and MATH 8062.

MATH 9991. Master's Research Projects. 1 to 6 Credit Hour.
Short-term, limited research project or laboratory project in the field. This course is not the capstone project course, nor can it be used for thesis based research. The course is for master's students only, including PSM, MA or MS. This class will not confer full-time program status unless nine credits are taken.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Degree Restrictions: Must be enrolled in one of the following Degrees: Master of Arts, Master of Science, Prof Science Masters.

Repeatability: This course may be repeated for additional credit.

MATH 9994. Preliminary Examination Preparation. 1 to 6 Credit Hour.
This course is required for students who are preparing for the preliminary or candidacy examination. Students should enroll after coursework is completed or when preparing for the candidacy exam until the time that the preliminary or candidacy examination is completed. This course will confer full-time status at the minimum credit hour registration limit of one credit. All students must complete a minimum of one credit of this course. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9995. Capstone Project. 1 to 6 Credit Hour.
Capstone project for master's students including students in PSM, MA or MS. This class will provide full-time status. Students in PSM programs need to register for at least one credit of this course to fulfill program requirements. Additional credits may be required for specific programs. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Degree Restrictions: Must be enrolled in one of the following Degrees: Master of Arts, Master of Science, Prof Science Masters.

Repeatability: This course may be repeated for additional credit.

MATH 9996. Master's Thesis Research. 1 to 6 Credit Hour.
Course for master's thesis research. Only intended for students in thesis bearing master's programs. A minimum of one credit is required. This course will confer full-time status at the minimum credit hour registration limit of one credit.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9998. Pre-Dissertation Research / Elevation to Candidacy. 1 to 6 Credit Hour.
This course is intended for students who are performing research prior to candidacy. Students can register for this course after required courses are completed. This course will confer full-time status at the minimum credit hour registration limit of one credit. Students must be registered for this course during the semester that they are to be elevated to candidacy examination. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for additional credit.

MATH 9999. Dissertation Research. 1 to 6 Credit Hour.
The course is for Ph.D. students who have been elevated to candidacy. During the course of their candidacy students must complete a minimum of two credits of dissertation research. This course will confer full-time status at the minimum credit hour registration limit of one credit. Students must complete a total of 6 credit hours of 9994, 9998 and 9999.

Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.
Student Attribute Restrictions: Must be enrolled in one of the following Student Attributes: Dissertation Writing Student.

Repeatability: This course may be repeated for additional credit.