Mathematics (MATH)

Courses

MATH 0701. Elementary Algebra. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
This course covers a basic treatment of algebraic expressions, linear equations and inequalities, polynomial operations, factoring, systems of linear equations, radical and rational expressions, quadratic equations, and various application problems. NOTE: This course does not count towards the number of credits required for graduation in the College of Science and Technology.

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 bridges the topics covered in Math 0701 and 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:
MATH 0701 to 1021| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MC2 Y|May not be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently
OR MC2A Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.
MATH 0823. Math for a Digital World. 4 Credit Hours.
This course is not offered every year.
How can I tell if an e-mail message is really from my bank? If I do online banking, can other people see the information? Does playing the lottery make sense? Does it make sense to draw for a run-off in such cases? How long will the world's oil last, assuming that we use more each year? How long will a million dollars last you, assuming it earns interest until you spend it? If you bought your text online, could someone tap into the Internet and get your credit card number when it's transmitted? Why does the VIN on your car have so many digits?

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 0823/0923 if they have successfully completed CIS 0823/0923.

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

Pre-requisites:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 0822| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 0824 to 1041| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

MATH 0824. Mathematical Patterns. 4 Credit Hours.
This course is typically offered in Fall, Spring, Summer I and Summer II.
News stories, everyday situations, and puzzling vignettes will be used to illuminate basic math concepts. Learn probability, for example, by discussing the gambler's fallacy and gambler's ruin, the drunkard's random walks, the Monty Hall problem, the St. Petersburg paradox, the hot hand, monkeys randomly typing on a typewriter, and many others. A similar approach involving estimation problems and puzzles will be taken in the units on basic numeracy and logic. Throughout the course, lectures and readings will examine the mathematical angles of stories in the news, suggesting fresh perspectives, questions, and ideas on current issues from google searches to the randomness of the iPod shuffle. 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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 0823| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 0825 to 1041| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.
Mathematics (MATH)

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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 0827| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 0829 to 1041| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

MATH 0923. Honors Math for a Digital World. 4 Credit Hours.
This course is not offered every year.
How can I tell if an e-mail message is really from my bank? If I do online banking, can other people see the information? Does playing the lottery make sense? Does it make sense to draw for an inside straight? How can polling results differ so much from the election — or do they? Sometimes the winner of an election in the U.S. gets much less than 50% of the vote. Would it make sense to have a run-off in such cases? How long will the world's oil last, assuming that we use more each year? How long will a million dollars last you, assuming it earns interest until you spend it? If you bought your text online, could someone tap into the Internet and get your credit card number when it's transmitted? Why does the VIN on your car have so many digits? (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 this course if they have successfully completed MATH 0823 or CIS 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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 0922| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 0924 to 1041| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently.
MATH 0924. Honors Mathematical Patterns. 4 Credit Hours.
This course is typically offered in Fall and Spring.
News stories, everyday situations, and puzzling vignettes will be used to illuminate basic math concepts. Learn probability, for example, by discussing the gambler's fallacy and gambler's ruin, the drunkard's random walks, the Monty Hall problem, the St. Petersburg paradox, the hot hand, monkeys randomly typing on a typewriter, and many others. A similar approach involving estimation problems and puzzles will be taken in the units on basic numeracy and logic. Throughout the course, lectures and readings will examine the mathematical angles of stories in the news, suggesting fresh perspectives, questions, and ideas on current issues from google searches to the randomness of the iPod shuffle. (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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 0923| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 0925 to 1041| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently.

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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C-|May not be taken concurrently
OR MATH 0800 to 1012| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MATH 1014 to 1021| Required Courses:1|Minimum Grade of C-|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR MA01 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently.
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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C|May not be taken concurrently
OR MATH 1021|Minimum Grade of C|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C|May be taken concurrently
OR STAT 1902|Minimum Grade of C|May be taken concurrently.

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:
MATH 0701 to 0702| Required Courses:1|Minimum Grade of C|May not be taken concurrently
OR MATH 1021 to 1022| Required Courses:1|Minimum Grade of D|May be taken concurrently
OR MC3 Y|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC3A Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR MA01 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C|May be taken concurrently
OR STAT 1902|Minimum Grade of C|May be taken concurrently.
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:
MATH 0702|Minimum Grade of C|May not be taken concurrently
OR MATH 1015|Minimum Grade of C|May not be taken concurrently
OR MATH 1022|Minimum Grade of D|May not be taken concurrently
OR MC4 Y|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently
OR MA01 Y|May not be taken concurrently
OR MA02 Y|May not be taken concurrently
OR STAT 1001|Minimum Grade of C-|May be taken concurrently
OR STT2 Y|May not be taken concurrently
OR STAT 1102|Minimum Grade of C-|May be taken concurrently
OR STAT 1902|Minimum Grade of C-|May be taken concurrently.

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:
MATH 1021|Minimum Grade of C|May not be taken concurrently
OR MATH 1041|Minimum Grade of D|May not be taken concurrently
OR MATH 1038|Minimum Grade of D|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MA03 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.
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:
MATH 1021|Minimum Grade of C|May not be taken concurrently
OR MC5 Y|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MA03 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

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:
MATH 1022|Minimum Grade of C-|May not be taken concurrently
OR MATH 1041|Minimum Grade of D|May not be taken concurrently
OR MATH 1042|Minimum Grade of D|May not be taken concurrently
OR MATH 1044|Minimum Grade of D|May not be taken concurrently
OR MATH 1941|Minimum Grade of D|May not be taken concurrently
OR MATH 1942|Minimum Grade of D|May not be taken concurrently
OR MATH 1951|Minimum Grade of D|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MA04 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.
MATH 1041. Calculus I. 4 Credit Hours.
This course is typically offered in Fall.
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:
MATH 1022|Minimum Grade of C|May not be taken concurrently
OR (MATH 1022|Minimum Grade of C-|May not be taken concurrently
AND MATH 1039|Minimum Grade of C|May be taken concurrently)
OR MATH 1042|Minimum Grade of D|May not be taken concurrently
OR MATH 1044|Minimum Grade of D|May not be taken concurrently
OR MATH 1942|Minimum Grade of D|May not be taken concurrently
OR MATH 1951|Minimum Grade of D|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MA04 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

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:
MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1941|Minimum Grade of C|May not be taken concurrently
OR MATH 1038|Minimum Grade of C|May not be taken concurrently
OR MATH 2043|Minimum Grade of D|May not be taken concurrently
OR MA06 Y|May not be taken concurrently.

MATH 1044. Introduction to Probability and Statistics for the Life Sciences. 4 Credit Hours.
This course is typically offered in Fall and Spring.
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:
MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1038|Minimum Grade of C|May not be taken concurrently
OR MATH 1941|Minimum Grade of C|May not be taken concurrently
OR MATH 1951|Minimum Grade of C|May not be taken concurrently
OR MATH 2043 to 3080| Required Courses: 1|Minimum Grade of C-|May be taken concurrently
OR MA06 Y|May not be taken concurrently.
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:
MATH 1022|Minimum Grade of C|May not be taken concurrently
OR MATH 1042|Minimum Grade of D|May not be taken concurrently
OR MATH 1044|Minimum Grade of D|May not be taken concurrently
OR MATH 1942|Minimum Grade of D|May not be taken concurrently
OR MATH 1951|Minimum Grade of D|May not be taken concurrently
OR MC6 Y|May not be taken concurrently
OR MA04 Y|May not be taken concurrently
OR MC6A Y|May not be taken concurrently.

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:
MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1941|Minimum Grade of C|May not be taken concurrently
OR MATH 1038|Minimum Grade of C|May not be taken concurrently
OR MATH 2043|Minimum Grade of D|May not be taken concurrently
OR MA06 Y|May not be taken concurrently.

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:
(MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1941|Minimum Grade of C|May not be taken concurrently
OR MATH 1038|Minimum Grade of C|May not be taken concurrently
OR MA06 Y|May not be taken concurrently)
AND (MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MA07 Y|May not be taken concurrently)
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:
(MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1951|Minimum Grade of C|May not be taken concurrently
AND (SCTC 1189|Minimum Grade of C|May not be taken concurrently
OR SCTC 1289|Minimum Grade of C|May not be taken concurrently
OR SCTC 1389|Minimum Grade of C|May not be taken concurrently
OR MGRE 3111|Minimum Grade of C|May not be taken concurrently)

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:
MATH 1031|Minimum Grade of C|May not be taken concurrently
OR MATH 1041|Minimum Grade of C|May not be taken concurrently
OR MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1044|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MATH 2043 to 3080| Required Courses:1|Minimum Grade of C|May be taken concurrently
OR STAT 1102|Minimum Grade of C|May not be taken concurrently
OR STAT 1902|Minimum Grade of C|May not be taken concurrently.

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:
MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MATH 1951|Minimum Grade of C|May not be taken concurrently
OR MA07 Y|May not be taken concurrently.
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:
- MATH 1042|Minimum Grade of C|May not be taken concurrently
- OR MATH 1942|Minimum Grade of C|May not be taken concurrently
- OR MATH 1951|Minimum Grade of C|May not be taken concurrently
- OR MATH 2043|Minimum Grade of C|May be taken concurrently
- OR MATH 2100 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently
- OR MA07 Y|May not be taken concurrently.

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:
- MATH 1042|Minimum Grade of C|May not be taken concurrently
- OR MATH 1942|Minimum Grade of C|May not be taken concurrently
- OR MATH 1951|Minimum Grade of C|May not be taken concurrently
- OR MA07 Y|May not be taken concurrently.

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:
- MATH 1042|Minimum Grade of C|May not be taken concurrently
- OR MATH 1942|Minimum Grade of C|May not be taken concurrently
- OR MATH 1951|Minimum Grade of C|May not be taken concurrently
- OR MA07 Y|May not be taken concurrently.

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:
- MATH 1042|Minimum Grade of C|May not be taken concurrently
- OR MATH 1942|Minimum Grade of C|May not be taken concurrently
- OR MATH 1951|Minimum Grade of C|May not be taken concurrently
- OR MATH 2043 to 2110| Required Courses:1|Minimum Grade of C-|May be taken concurrently
- OR MATH 2112 to 3080| Required Courses:1|Minimum Grade of C-|May be taken concurrently
- OR MA07 Y|May not be taken concurrently.
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:
MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MATH 1951|Minimum Grade of C|May not be taken concurrently
OR MA07 Y|May not be taken concurrently.

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:
MATH 2111|Minimum Grade of C-|May not be taken concurrently.

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:
MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MATH 1951|Minimum Grade of C|May not be taken concurrently
OR MATH 2043|Minimum Grade of C-|May be taken concurrently
OR MA07 Y|May not be taken concurrently.

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:
MATH 3031|Minimum Grade of C-|May not be taken concurrently
OR AS 2101|Minimum Grade of C-|May not be taken concurrently.

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:
MATH 2043|Minimum Grade of C-|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:
MATH 3041|Minimum Grade of C-|May not be taken concurrently
OR MATH 3045|Minimum Grade of C-|May not be taken concurrently.

MATH 3043. Numerical Analysis I. 3 to 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:
(MATH 2043|Minimum Grade of C-|May not be taken concurrently)
AND (MATH 2101|Minimum Grade of C-|May not be taken concurrently)
OR MATH 2103|Minimum Grade of C-|May not be taken concurrently)
AND (CIS 1053|Minimum Grade of C-|May not be taken concurrently)
OR CIS 1057|Minimum Grade of C-|May not be taken concurrently)
OR CIS 1068|Minimum Grade of C-|May not be taken concurrently
OR PHYS 2501|Minimum Grade of C-|May not be taken concurrently

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:
MATH 3043|Minimum Grade of C-|May not be taken concurrently.

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:
MATH 2043|Minimum Grade of C|May be taken concurrently
OR MA08 Y|May not be taken concurrently.

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:
MATH 2043|Minimum Grade of C|May be taken concurrently
OR MA08 Y|May not be taken concurrently.
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:
(MATH 2111|Minimum Grade of C|May not be taken concurrently)
AND (MATH 3045|Minimum Grade of C-|May not be taken concurrently
OR MATH 2101|Minimum Grade of C-|May not be taken concurrently)

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. NOTE: This course is primarily intended for math education majors.

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

Pre-requisites:
(MATH 2061|Minimum Grade of C-|May not be taken concurrently
OR MATH 2111|Minimum Grade of C-|May not be taken concurrently)
AND (MATH 2101|Minimum Grade of C-|May not be taken concurrently
OR MATH 2103|Minimum Grade of C-|May not be taken concurrently
OR MATH 3051|Minimum Grade of C-|May not be taken concurrently)

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:
MATH 2111|Minimum Grade of C-|May not be taken concurrently.
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:
(MATH 2111 | Minimum Grade of C | May not be taken concurrently)
AND (MATH 2101 | Minimum Grade of C | May not be taken concurrently
OR MATH 2103 | Minimum Grade of C | May not be taken concurrently
OR MATH 3045 | Minimum Grade of C | May not be taken concurrently
OR MA09 Y | May not be taken concurrently
OR MA10 Y | May not be taken concurrently)

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:
MATH 3098 | Minimum Grade of C | May not be taken concurrently.

MATH 3137. Real & Complex Analysis I. 3 Credit Hours.
This course is typically offered in Fall.

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

Pre-requisites:
(MATH 2043 | Minimum Grade of C | May not be taken concurrently
OR MA08 Y | May not be taken concurrently)
AND (MATH 2111 | Minimum Grade of C | May not be taken concurrently)

MATH 3138. Real & Complex Analysis II. 3 Credit Hours.
This course is typically offered in Spring.

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

Pre-requisites:
MATH 3137 | Minimum Grade of C | May not be taken concurrently
OR MATH 3141 | Minimum Grade of C | May not be taken concurrently.
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:
(MATH 2043|Minimum Grade of C|May not be taken concurrently
OR MA08 Y|May not be taken concurrently)
AND (MATH 2111|Minimum Grade of C|May not be taken concurrently
OR MA11 Y|May not be taken concurrently)
AND (MATH 2101|Minimum Grade of C|May not be taken concurrently
OR MATH 2103|Minimum Grade of C|May not be taken concurrently
OR MATH 3045|Minimum Grade of C|May not be taken concurrently
OR MA09 Y|May not be taken concurrently
OR MA10 Y|May not be taken concurrently)

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:
MATH 3141|Minimum Grade of C-|May not be taken concurrently.

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:
MATH 1042|Minimum Grade of C|May not be taken concurrently
OR MATH 1942|Minimum Grade of C|May not be taken concurrently
OR MATH 2043|Minimum Grade of C-|May be taken concurrently
OR MATH 2943|Minimum Grade of C-|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:
MATH 3001 to 4999| Required Courses:1|Minimum Grade of C|May not be taken concurrently.

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:
MATH 2111|Minimum Grade of C-|May not be taken concurrently
OR MATH 2196|Minimum Grade of C-|May not be taken concurrently
OR MATH 3003|Minimum Grade of C-|May not be taken concurrently.
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:
MATH 3031|Minimum Grade of C-|May not be taken concurrently
OR MATH 3033|Minimum Grade of C-|May not be taken concurrently
OR AS 2101|Minimum Grade of C-|May not be taken concurrently.

MATH 4041. Partial Differential Equations. 3 Credit Hours.
This course is typically offered in Spring.

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

Pre-requisites:
(MATH 2101|Minimum Grade of C-|May not be taken concurrently
OR MATH 2103|Minimum Grade of C-|May not be taken concurrently
OR MATH 3051|Minimum Grade of C-|May not be taken concurrently)
AND (MATH 3041|Minimum Grade of C-|May not be taken concurrently
OR MATH 3045|Minimum Grade of C-|May not be taken concurrently)

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:
(MATH 2101|Minimum Grade of C-|May not be taken concurrently
OR MATH 2103|Minimum Grade of C-|May not be taken concurrently
OR MATH 3051|Minimum Grade of C-|May not be taken concurrently)
AND (MATH 3041|Minimum Grade of C-|May not be taken concurrently
OR MATH 3045|Minimum Grade of C-|May not be taken concurrently
OR MATH 3046|Minimum Grade of C-|May not be taken concurrently)

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:
MATH 3138|Minimum Grade of C|May not be taken concurrently
OR MATH 3142|Minimum Grade of C|May not be taken concurrently
OR MA12 Y|May not be taken concurrently.
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:
(MATH 2043|Minimum Grade of C|May not be taken concurrently
OR MA08 Y|May not be taken concurrently)
AND (MATH 2101|Minimum Grade of C|May not be taken concurrently
OR MATH 2103|Minimum Grade of C|May not be taken concurrently
OR MATH 3051|Minimum Grade of C|May not be taken concurrently)

MATH 4063. Topology I. 3 Credit Hours.
This course is typically offered in Spring of odd years.

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

Pre-requisites:
(MATH 3137|Minimum Grade of C|May not be taken concurrently
OR MATH 3141|Minimum Grade of C|May not be taken concurrently)
AND (MATH 3096|Minimum Grade of C|May not be taken concurrently
OR MATH 3098|Minimum Grade of C|May not be taken concurrently)

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:
(MATH 3138|Minimum Grade of C|May be taken concurrently
OR MATH 3142|Minimum Grade of C|May be taken concurrently
OR MATH 3044|Minimum Grade of C|May be taken concurrently)
AND (MATH 3096|Minimum Grade of C|May not be taken concurrently
OR MATH 3098|Minimum Grade of C|May not be taken concurrently)

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 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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 5041|Minimum Grade of B-|May not be taken concurrently.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

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

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 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 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:
MATH 5061|Minimum Grade of B-|May be taken concurrently.

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 8007. 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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

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

MATH 8008. 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 8007.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 8011|Minimum Grade of B-|May not be taken concurrently.

MATH 8013. Numerical Linear Algebra I. 3 Credit Hours.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 8013|Minimum Grade of B-|May not be taken concurrently.
MATH 8023. Numerical Differential Equations I. 3 Credit Hours.

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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.

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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:**
MATH 8023|Minimum Grade of B-|May not be taken concurrently.

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.

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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:**
MATH 8031|Minimum Grade of B-|May not be taken concurrently.

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

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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.

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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:**
MATH 8041|Minimum Grade of B-|May not be taken concurrently.

MATH 8051. Functions of a Complex Variable I. 3 Credit Hours.

**Department Restrictions:** Must be enrolled in one of the following Departments: CST:Mathematics.
**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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 8051|Minimum Grade of B-|May not be taken concurrently.

MATH 8061. Differential Geometry and Topology I. 3 Credit Hours.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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.
Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 8061|Minimum Grade of B-|May not be taken concurrently.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics, Engineering: Engineering.
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:
(MATH 8007|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8008|Minimum Grade of B-|May not be taken concurrently)

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

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 8141|Minimum Grade of B-|May not be taken concurrently.
MATH 8161. Topology. 3 Credit Hours.
Point set topology through the Urysohn Metrization Theorem; fundamental group and covering spaces. Differential forms; the DeRham groups.

Department Restrictions: Must be enrolled in one of the following Departments: CST: Mathematics.
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:
MATH 5041 | Minimum Grade of B- | May not be taken concurrently.

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 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.

Department Restrictions: Must be enrolled in one of the following Departments: CST: Mathematics.
Level Registration Restrictions: Must be enrolled in one of the following Levels: Graduate.

Repeatability: This course may be repeated for a total of 3 credit.

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 Poincaré series and theta series. Other topics: the Hecke correspondence between modular forms and Dirichlet series with functional equations, the Petersson 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 Poincaré series and theta series. Other topics: the Hecke correspondence between modular forms and Dirichlet series with functional equations, the Petersson 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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8011|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8012|Minimum Grade of B-|May not be taken concurrently)

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8011|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8012|Minimum Grade of B-|May not be taken concurrently)
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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 9012|Minimum Grade of B-|May not be taken concurrently.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8011|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8012|Minimum Grade of B-|May not be taken concurrently)

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 9014|Minimum Grade of B-|May not be taken concurrently.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8061|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8062|Minimum Grade of B-|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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8061|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8062|Minimum Grade of B-|May not be taken concurrently)

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 9023|Minimum Grade of B-|May not be taken concurrently.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
(MATH 8041|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8042|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8161|Minimum Grade of B-|May not be taken concurrently)

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.
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:
MATH 9041|Minimum Grade of B-|May not be taken concurrently.
MATH 9043. Calculus of Variations. 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.

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.

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.

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:
(MATH 8051|Minimum Grade of B-|May not be taken concurrently)
AND (MATH 8052|Minimum Grade of B-|May not be taken concurrently)

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

Department Restrictions: Must be enrolled in one of the following Departments: CST:Mathematics.

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:
MATH 9051|Minimum Grade of B-|May not be taken concurrently.

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 Teichmüller 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 Teichmüller 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 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, Sparse 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, Sparse 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 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 one of the following Levels: Graduate.

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.