MATHEMATICS

Students interested in specializing in Mathematics and intending to do either graduate work in Mathematics or work in business or industry will be interested in this degree. The Mathematics Department Degree Program prepares students for employment in the private or public sector, graduate school, and scientific research. Studying Mathematics naturally develops quantitative thinking and analytic problem solving, talents with universal application. Demand will always be high for individuals with these universal talents to solve society’s diverse and complex problems.

Seven concentrations and a No Concentration Option are available for a Bachelor of Arts and a Bachelor of Science.

Other Information
All coursework taken for the Mathematics major or minor must be completed with a grade of "C-" or better.

Double Majors
If planned correctly, some disciplines, such as Computer Science and Math 6-12 Teaching endorsement, require few, if any, additional math courses beyond what is required for the major.

Student Groups
Math Club
Pi Mu Epsilon National Mathematics Honorary Society
Putnam Competition

Contact
Advisor/Academic Coordinator, Debbie Challman
DSC 204
402-554-3841

Website (http://www.unomaha.edu/college-of-arts-and-sciences/mathematics/mathematics-bs)

Writing in the Discipline
All students are required to take a writing in the discipline course within their major. For the Math major, select one of the following:

<table>
<thead>
<tr>
<th>Code</th>
<th>Title</th>
<th>Credits</th>
</tr>
</thead>
<tbody>
<tr>
<td>ENGL 3980</td>
<td>TECHNICAL WRITING ACROSS THE DISCIPLINES</td>
<td>3</td>
</tr>
<tr>
<td>ENGL 3050</td>
<td>WRITING FOR THE WORKPLACE</td>
<td>3</td>
</tr>
<tr>
<td>ENGR 3000</td>
<td>CREATIVITY &amp; WRITNG FOR ENGNRS</td>
<td>3</td>
</tr>
<tr>
<td>CIST 3000</td>
<td>ADVANCED COMPOSITION FOR IS &amp; T</td>
<td>3</td>
</tr>
</tbody>
</table>

Bachelor of Arts and Bachelor of Science in Mathematics

The B.A. and B.S. Degrees with a major in Mathematical Sciences consists of 47 credits of required courses in Mathematics. Approved Statistics courses may also be included. Either degree option has seven possible Concentrations and a No Concentration Option. The Concentrations are defined by the required upper division courses.

Degrees Offered
• Mathematics, Bachelor of Arts (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/mathematics/mathematics-ba)
• Mathematics, Bachelor of Science (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/mathematics/mathematics-bs)

The Bachelor of Arts Degree requires foreign language through the intermediate level.

The Bachelor of Science Degree requires 18 credits in cognate courses outside the Math Department and approved by the Math Department Curriculum Committee as a cohesive group of courses, normally with at least 9 credits 3000 or 4000 level.

Minors Offered
• Math Minor (http://catalog.unomaha.edu/undergraduate/college-arts-sciences/mathematics/math-minor)

MATH 1000 PRE-INTERMEDIATE ALGEBRA (2 credits)
An introductory level algebra course designed to prepare students to be successful in MATH 1310 (Intermediate Algebra). Topics include whole numbers, integers, fractions and mixed numbers, decimals, simplifying mathematical expressions, the properties of equality, solving linear equations in one variable, using linear equations to solve problems, ratios and proportions, graphing and the rectangular coordinate system. This course is worth two credit hours and will not satisfy the Math General Education requirement.

Prerequisite(s)/Corequisite(s): ACT Math sub score of 11-18, Math SAT at least 220 or Math SAT2016 at least 230 within the last 5 years; or Accuplacer score of 1 or COMPASS score of 1 or 2 within the last two years; or an F or better in MATH 1000 within the last 2 years

MATH 1200 QUANTITATIVE LITERACY (3 credits)
Relevant mathematical skills for educated citizens in today's society. Topics include: personal finance; linear equations and inequalities in one and two variables; quadratic, exponential and logarithmic functions; probability and statistics; and systems of equations. This course is intended to satisfy the general education mathematics requirement. It does not serve as a prerequisite for any other mathematics course.

Prerequisite(s)/Corequisite(s): Math ACT score of 19 (or equivalent MPE) within the last two years.

MATH 1310 INTERMEDIATE ALGEBRA (3 credits)
This course presents properties of real numbers, linear equations and graphing, systems of equations, linear inequalities, quadratic equations, polynomials, algebraic fractions, exponents and radicals, and logarithms.

Prerequisite(s)/Corequisite(s): ACT Math at least 19, Math SAT at least 460, or Math SAT2016 at least 500 within the last 5 years; or Accuplacer or COMPASS score at least 3 within the last 2 years; or MATH 1000 with C- or better within the last 2 years; or MATH 1310 within last 2 years

Distribution: Math

MATH 1320 COLLEGE ALGEBRA (3 credits)
An advanced algebra course that teaches the following topics: algebraic operations, functions, graphs, linear and quadratic equations and inequalities, polynomial and rational functions, systems of equations, binomial theorem, complex numbers, exponentials, logarithms, sequences, series, and combinatorics.

Prerequisite(s)/Corequisite(s): ACT Math at least 23, Math SAT at least 540, or Math SAT2016 at least 570 within the last 5 years; or Accuplacer or COMPASS score at least 4 within the last 2 years; or MATH 1310 with at least C- within the last 2 years; or MATH 1320 within last 2 years

MATH 1330 TRIGONOMETRY (3 credits)
This course introduces elements of plane trigonometry, including trigonometric and circular functions, inverse trigonometric functions, solutions of triangles, identities and conditional equations, vectors, complex numbers, and conic sections.

Prerequisite(s)/Corequisite(s): ACT Math at least 23, Math SAT at least 540, or Math SAT2016 at least 570 within last 5 years; or Accuplacer at least 5 or COMPASS at least 4 within last 2 years; or MATH 1320 with at least C- within last 2 years; or MATH 1330 within last 2 years
MATH 1340 ALGEBRA AND TRIGONOMETRY FOR CALCULUS (5 credits)
A combined algebra and trigonometry course for science and engineering students planning to enroll in MATH 1950. Topics include: systems of equations, polynomials and rational functions, exponential and logarithmic functions, trigonometric functions and their inverses, trigonometric identities and applications, conic sections, and complex numbers. Credit for both MATH 1320/MATH 1324 and MATH 1340, or both MATH 1330 and MATH 1340 will not be given.
Prerequisite(s)/Corequisite(s): ACT Math at least 23, Math SAT at least 540, or Math SAT2016 at least 570 within last 5 years; or Accuplacer at least 5 or COMPASS at least 4 within last 2 years; or MATH 1310 with at least C- within last 2 years; or MATH 1340 within last 2 years

MATH 1360 APPLIED ALGEBRA WITH DATA ANALYSIS (3 credits)
This is an applied algebra course teaching the following topics with an emphasis on data analysis and application: algebraic, exponential, and logarithmic functions; probability and statistics. The course will emphasize data analysis and applications of covered topics in order to demonstrate the relevance of mathematics to solving real-world problems.
Prerequisite(s)/Corequisite(s): Students must have an ACT Math sub score of at least 23 within the last 2 years, a COMPASS Test score of at least 4 within the last 2 years, or MATH 1310 within the last 2 years with a grade of C- or better.

MATH 1370 APPLIED ALGEBRA AND OPTIMIZATION WITH DATA ANALYSIS (4 credits)
This is an applied algebra course with optimization, teaching the following topics with an emphasis on data analysis and application: algebraic, exponential, and logarithmic functions; derivatives and applications thereof; and statistics. The course will emphasize data analysis and applications of covered topics in order to demonstrate the relevance of mathematics to solving real-world problems.
Prerequisite(s)/Corequisite(s): ACT Math sub score at least 23, Math SAT at least 540, or Math SAT2016 at least 570 within last 5 years; or Accuplacer or COMPASS score at least 4 within last 2 years; or MATH 1310 within last 2 years

MATH 1530 INTRODUCTION TO APPLIED PROBABILITY AND STATISTICS (3 credits)
An elementary introduction to the basic concepts of probability, descriptive statistics, and statistical inference, including point estimation, confidence intervals, and hypotheses testing.
Prerequisite(s)/Corequisite(s): ACT Math sub score at least 19, Math SAT at least 460, or Math SAT2016 at least 500 within last 5 years; Accuplacer or COMPASS score at least 3 within last 2 years; or MATH 1000 with C- or better within last 2 years; or MATH 1530 within last 2 years

MATH 1600 COMPUTER ALGEBRA (1 credit)
An introductory course to computer algebra systems such as MAPLE or MATHEMATICA. The course will discuss files and their management, the graphing capabilities of the package will be explored.
Prerequisite(s)/Corequisite(s): MATH 1320 or equivalent.

MATH 1930 CALCULUS FOR THE MANAGERIAL, LIFE, AND SOCIAL SCIENCES (3 credits)
Basic ideas of calculus are surveyed with applications: functions, limits, derivatives, and integrals. Trigonometry is not required. May not be used as a prerequisite for MATH 1960. Credit will not be granted for both MATH 1930 and MATH 1950.
Prerequisite(s)/Corequisite(s): ACT Math sub score at least 25, Math SAT at least 570, or Math SAT2016 at least 590 within last 5 years; or Accuplacer or COMPASS score at least 6 within last 2 years; or MATH 1320 with at least C- within last 2 years; or MATH 1930 within last 2 years

MATH 1940 CALCULUS FOR BIOMEDICINE (5 credits)
Introductory calculus with an emphasis on dynamical systems analysis applied to biological systems. Topics include differential and integral calculus, elementary chaos theory, discrete modeling, neural networks, and elementary differential equations, population dynamics, and biochemical signal transduction.
Prerequisite(s)/Corequisite(s): ACT Math sub score at least 25, Math SAT at least 570, or Math SAT2016 at least 590 within last 5 years; or Accuplacer or COMPASS score at least 6 within last 2 years; or MATH 1320 with at least C- within last 2 years; or permission of instructor

MATH 1950 CALCULUS I (5 credits)
This is a course in plane analytic geometry emphasizing the study of functions, limits, derivatives and applications, and an introduction to integration.
Prerequisite(s)/Corequisite(s): ACT Math sub score at least 26, Math SAT at least 590 or Math SAT2016 at least 610 within last 5 years; or Accuplacer or COMPASS score of 7 within last 2 years; or MATH 1320 and MATH 1330 or MATH 1340 with C- or better within last 2 years

MATH 1960 CALCULUS II (5 credits)
This course introduces applications of integration, techniques of integration, infinite sequences and series, vectors in the plane, and polar functions. A mathematical software package is introduced, with required assignments.
Prerequisite(s)/Corequisite(s): MATH 1950 with a grade of C- or better, or MATH 1960 with a grade of F or better, or permission of instructor.

MATH 1970 CALCULUS III (4 credits)
This course presents vector functions, parametric equations, solid analytic geometry, partial differentiation, multiple integration, and an introduction to vector calculus. A mathematical software package is introduced with required assignments.
Prerequisite(s)/Corequisite(s): MATH 1960 with a grade of C- or better, or MATH 1970 with a grade of F or better, or permission of instructor.

MATH 2040 FIN DISC MATH FOR INFO SCI/ENG (3 credits)
A foundations course in discrete mathematics for applied disciplines, including computer science and computer engineering. Topics include: logic, sets, relations, functions, complexity functions and big congruences, induction and recursive definitions, elementary combinatorics, discrete probability, graphs and trees.
Prerequisite(s)/Corequisite(s): MATH 1950 or MATH 1930.

MATH 2050 APPLIED LINEAR ALGEBRA (3 credits)
This course presents Matrix algebra, simultaneous equations, vector spaces, with applications of linear algebra and computational considerations. Mathematical software is utilized, with required assignments.
Prerequisite(s)/Corequisite(s): MATH 1950 with a grade of C- or better

MATH 2200 MATHEMATICAL COMPUTING I (3 credits)
This is a first course in mathematical computing. It covers the basic elements of scientific programming in both a computer algebra system and a high-level programming language. Explored are implementation issues, problem description, model building, method development, and solution assessment.
Prerequisite(s)/Corequisite(s): MATH 1950
MATH 2230 INTRODUCTION TO ABSTRACT MATH (3 credits)
This course provides a transition from the calculus to more abstract mathematics. Topics include logic, sets and functions, an introduction to mathematical proof, mathematical induction, relations. Important prerequisite material for a number of more advanced mathematics courses is studied. Credit will not be given for both MATH 2030 (or MATH 2040) and MATH 2230.
Prerequisite(s)/Corequisite(s): MATH 1960 or permission

MATH 2350 DIFFERENTIAL EQUATIONS (3 credits)
Topics include solutions of linear and first-order nonlinear differential equations with applications, higher-order linear differential equations with applications, power series solutions, and Laplace transform methods.
Prerequisite(s)/Corequisite(s): MATH 1960 with a grade of C- or better

MATH 3100 APPLIED COMBINATORICS (3 credits)
Basic counting methods, generating functions, recurrence relations, principle of inclusion-exclusion. Polya’s formula. Elements of graph theory, trees and searching network algorithms. (Cross-listed with MATH 8105, CSCI 3100, CSCI 8105).
Prerequisite(s)/Corequisite(s): MATH 2030 with a C- or better or MATH 2040 with a C- or better or MATH 2230 with a C- or better.

MATH 3200 MATHEMATICAL COMPUTING II (3 credits)
This course is a second course in mathematical computing. It covers the design and development of algorithms and more advanced elements of programming in a mathematical context. The computer algebra system Maple will be used. The programming assignments are primarily based on calculus concepts and are designed to reinforce and deepen the understanding of these concepts.
Prerequisite(s)/Corequisite(s): CIST 1400 or MATH 2200, and MATH 1960 with a C- or better or MATH 2230.

MATH 3300 NUMERICAL METHODS (3 credits)
This course involves solving nonlinear algebraic equations and systems of equations, interpolation and polynomial approximation, numerical differentiation and integration, numerical solutions to ordinary differential equations, analysis of algorithms and errors, and computational efficiency. (Cross-listed with MATH 8305, CSCI 3300, CSCI 8305).
Prerequisite(s)/Corequisite(s): MATH 1960 with a C- or better or permission of instructor

MATH 3400 THEORY OF INTEREST (3 credits)
A study of the measurement of interest, annuities, amortization schedules and other miscellaneous topics.
Prerequisite(s)/Corequisite(s): MATH 1970

MATH 3500 SELECTED TOPICS IN MATHEMATICS (1-6 credits)
This is a variable content course with selected topics in the mathematical sciences which may be of interest to students in other disciplines such as mathematics education, psychology and business. The course may be taken more than once for credit provided topics differ, with a maximum of nine hours. Mathematics majors may apply no more than three hours of MATH 3500 toward the minimum major requirements. (Cross-listed with MATH 8505).
Prerequisite(s)/Corequisite(s): Permission of instructor.

MATH 3640 MODERN GEOMETRY (3 credits)
Axiomatic systems, finite geometries, modern foundations of Euclidean geometry, hyperbolic and other non-Euclidean geometries, projective geometry. (Cross-listed with MATH 8645).
Prerequisite(s)/Corequisite(s): MATH 2230 or MATH 2030, or equivalent mathematical maturity.

MATH 3850 HISTORY OF MATHEMATICS (3 credits)
An overview of the historical development of mathematical concepts and methods. Brief biographies of major mathematicians, descriptions of the cultural context of selected major advances and examples of the solution of problems using the knowledge and methods appropriate for each time period will be included. (Cross-listed with MATH 8855).
Prerequisite(s)/Corequisite(s): Students who enroll in this course should have completed MATH 1970 and MATH 2230 in order to have the minimum amount of mathematical background needed to appreciate the mathematical content of the course.

MATH 4010 INTRODUCTION TO THE THEORY OF RECURSIVE FUNCTIONS (3 credits)
This is a proof-oriented course presenting the foundations of Recursion Theory. We present the definition and properties of the class of primitive recursive functions, study the formal models of computation, and investigate partially computable functions, universal programs. We prove Rice’s Theorem, the Recursion Theorem, develop the arithmetic hierarchy, demonstrate Post’s theorem. Introduction to the formal theories of computability and complexity is also given. (Cross-listed with CSCI 4010, CSCI 8016, MATH 8016).
Prerequisite(s)/Corequisite(s): MATH 2230 or CSCI 3660 or instructor’s permission.

MATH 4030 MODERN ALGEBRA (3 credits)
Algebra is the study of mathematical manipulations that preserve something (like equality - when solving equations). The areas in which Algebra finds application are quite diverse, from Ancient Greek Geometry through to Modern Information Protection and Security (error correcting codes, data compression, and cryptography). This course begins with topics that should be familiar (such as ruler-and-compass constructions, and modular arithmetic) and builds upon this foundation through polynomial rings up to finite fields and basic group theory. (Cross-listed with MATH 8036).
Prerequisite(s)/Corequisite(s): MATH 2230 with a C- or better or MATH 2030 with a C- or better.

MATH 4050 LINEAR ALGEBRA (3 credits)
The theory of vectors, vector spaces, inner product spaces, linear transformations, eigenvalues, canonical forms, complex vectors and matrices and orthogonality. Unlike MATH 2050, this course emphasizes the theoretical aspects of linear algebra. (Cross-listed with MATH 8056).
Prerequisite(s)/Corequisite(s): MATH 2050; MATH 2030 or MATH 2230 or equivalent; or permission

MATH 4110 ABSTRACT ALGEBRA I (3 credits)
An introduction to group theory. Various classes of group are studied: symmetric groups, abelian, cyclic, and permutation groups. Basic tools are developed and used: subgroups, normal subgroups, cosets, the Lagrange theorem, group homomorphisms, quotient groups, direct products, and group actions on a set. The course culminates with the Sylow theorems in finite group theory. The theory is illustrated with examples from geometry, linear algebra, number theory, crystallography, and combinatorics. (Cross-listed with MATH 8116).
Prerequisite(s)/Corequisite(s): MATH 4050/MATH 8056 with a C- or better or MATH 4560/MATH 8566 with a C- or better or permission of instructor.
MATH 4210 ABSTRACT ALGEBRA II (3 credits)
An introduction to ring and field theory. Various classes of commutative
rings are considered including polynomial rings, and the Gaussian integers.
Examples of fields include finite fields and various extensions of the
rational numbers. Concepts such as that of an ideal, integral domain,
characteristic and extension field are studied. The course culminates with
an introduction to Galois theory. Applications include the resolution of two
classical problems: the impossibility of angle-trisection and the general
insolvability of polynomial equations of degree 5 or higher. (Cross-listed with
MATH 8126).
Prerequisite(s)/Corequisite(s): MATH 4110/MATH 8116 with a C- or
better or permission of instructor.

MATH 4215 GRAPH THEORY & APPLICATIONS (3 credits)
Introduction to graph theory. Representations of graphs and graph
isomorphism. Trees as a special case of graphs. Connectivity, covering,
matching and coloring in graphs. Directed graphs and planar graphs.
Applications of graph theory in several fields such as networks, social
sciences, VLSI, chemistry and parallel processing. (Cross-listed with
MATH 8156, CSCI 4150, CSCI 8156).
Prerequisite(s)/Corequisite(s): MATH 2030 or permission of instructor.

MATH 4230 MATHEMATICAL ANALYSIS I (3 credits)
Provides a theoretical foundation for the concepts of elementary calculus.
Topics include ordered fields and the real number system, basic properties
of complex numbers, metric space topology, sequences and series in Rk,
limits and continuity in a metric space, monotonic functions. (Cross-listed with
MATH 8236).
Prerequisite(s)/Corequisite(s): MATH 3230/MATH 8235

MATH 4240 MATHEMATICAL ANALYSIS II (3 credits)
Provides a theoretical foundation for the concepts of elementary calculus.
Topics include differentiation and Riemann-Stieltjes Integration, sequences
and series of functions, uniform convergence, power series, functions of
several variables, Implicit Function Theorem. (Cross-listed with MATH 8246).
Prerequisite(s)/Corequisite(s): MATH 4230

MATH 4270 COMPLEX VARIABLES (3 credits)
Differentiation, integration and power series expansions of analytic
functions, conformal mapping, residue calculus and applications. (Cross-
listed with MATH 8276).
Prerequisite(s)/Corequisite(s): MATH 3230/MATH 8235 or equivalent.

MATH 4300 DETERMINISTIC OPERATIONS RESEARCH MODELS (3
credits)
This is a survey course of deterministic operations research models and
algorithms. Topics include linear programming, network programming,
and integer programming. (Cross-listed with CSCI 4300, CSCI 8306,
MATH 8306).
Prerequisite(s)/Corequisite(s): MATH 2050 with a C- or better or
permission of instructor.

MATH 4310 PROBABILISTIC OPERATIONS RESEARCH MODELS (3
credits)
This is a survey course of probabilistic operations, research models and
algorithms. Topics include Markov chains, queueing theory, inventory
models, forecasting, and simulation. (Cross-listed with CSCI 4310,
CSCI 8316, MATH 8316).
Prerequisite(s)/Corequisite(s): MATH 2050 and either MATH 4740 or
MATH 8746 or STAT 3800 or STAT 8805 all with a C- or better or permission of
instructor.

MATH 4320 COMPUTATIONAL OPERATIONS RESEARCH (3 credits)
Survey of computational methods used in the solution of operations
research problems. Topics include scripting to guide optimization software,
metaheuristics for optimization, and basic machine learning algorithms.
(Cross-listed with MATH 8326).
Prerequisite(s)/Corequisite(s): MATH 3200 and MATH 4300 each with a
grade of C- or better or permission of instructor.

MATH 4330 INTRODUCTION TO PARTIAL DIFFERENTIAL EQUATIONS
(3 credits)
This course introduces the basic methods of PDEs guided by applications in
physics and engineering. The main topics to be covered include The Linear
First order PDEs, Transport equations, Characteristics, Classification of
PDEs, Separation of variables, Heat conduction, vibrating membranes,
boundary value problems, Maximum principle, Sturm-Liouville problems,
Fourier series, Fourier integrals, Harmonic functions, Legendre polynomials,
Distributions, Green's functions... (Cross-listed with MATH 8336).
Prerequisite(s)/Corequisite(s): MATH 1970 with a C- or better and
MATH 2350 with a C- or better, or permission of instructor; MATH 2050
recommended, not required.

MATH 4350 ORDINARY DIFFERENTIAL EQUATIONS (3 credits)
Ordinary Differential Equations develops the theory of initial-, boundary-,
eigenvalue problems, existence theorems, real and complex linear
systems of differential equations, and stability theory. There will be a strong
emphasis on methods for finding solutions of initial and boundary value
problems and analyzing properties of these solutions for various differential
equations. (Cross-listed with MATH 8356).
Prerequisite(s)/Corequisite(s): MATH 2050 with a C- or better and
MATH 2350 with a C- or better or instructor's permission. It is
recommended, but not required, that students take MATH 3230, which
would require a C- or better.

MATH 4400 FINITE ELEMENT METHODS FOR SOLVING ORDINARY
AND PARTIAL DIFFERENTIAL EQUATIONS (3 credits)
Introduction to finite elements methods for solving ordinary and partial
differential equations. Theoretical foundations of finite element methods
for boundary value problems, approximation by piecewise polynomial
functions, variation formulation of partial differential equations, basic
error estimates. The Rayleigh-Ritz-Galerkin method, convergence of
approximations, time-dependent problems, error analysis, discretization
and computer implementation, applications to problems in elasticity, heat
transfer, and fluid mechanics. (Cross-listed with MATH 8406).
Prerequisite(s)/Corequisite(s): MATH 1970 with a C- or better,
MATH 2050 with a C- or better, and MATH 2350 with a C- or better,
or instructor's permission. MATH 3300/MATH 8305 and MATH 4330/
MATH8336 are recommended, but not required. Familiarity with MATLAB
programming is assumed.

MATH 4560 NUMBER THEORY & CRYPTOGRAPHY (3 credits)
An overview of one of the many beautiful areas of mathematics and its
modern application to secure communication. The course is ideal for
any student who wants a taste of mathematics outside of, or in addition to,
the calculus sequence. Topics to be covered include: prime numbers,
congruences, perfect numbers, primitive roots, quadratic reciprocity,
sums of squares, and Diophantine equations. Applications include error-
correcting codes, symmetric and public key cryptography, secret sharing,
and zero knowledge proofs. (Cross-listed with MATH 8566, CSCI 4560,
CSCI 8566).
Prerequisite(s)/Corequisite(s): MATH 2230 with a C- or better
MATH 2350 with a C- or better or CSCI 2030 with a C- or better or
numbers are recommended, but not required, that students take MATH 3230, which
would require a C- or better.

MATH 4580 TENSOR ANALYSIS (3 credits)
Review of vector spaces and matrix theory, tensor algebra, the metric tensor
and tensors, geodesics, applications to geometry, mechanics,
relativity, and continuous media. (Cross-listed with MATH 8586).
Prerequisite(s)/Corequisite(s): MATH 1970, MATH 2050, MATH 2350

MATH 4600 DIFFERENTIAL GEOMETRY (3 credits)
Curvature, torsion, Frenet frames, Fundamental theorem of curve theory,
Frenet's theorem, tangent spaces, first and second fundamental forms,
shape operator, Fundamental theorem of surfaces theory, covariant
derivative, parallel transport, geodesics. (Cross-listed with MATH 8606).
Prerequisite(s)/Corequisite(s): MATH 1970 with a C- or better,
MATH 2050 with a C- or better, and MATH 2350 with a C- or better, or
permission of instructor.
MATH 4610 ELEMENTARY TOPOLOGY (3 credits)
This course covers topological spaces, connectedness, compactness, homotopy of paths, covering spaces, and fundamental groups. (Cross-listed with MATH 8616).
Prerequisite(s)/Corequisite(s): MATH 1960 with a C- or better and MATH 3230 with a C- or better or permission of instructor.

MATH 4650 TRANSFORM METHODS & APPLICATIONS (3 credits)
Laplace transform and the inversion integral. Fourier transform. Other transforms and special techniques. Applications to differential equations, boundary value problems of mathematical physics and signal analysis. (Cross-listed with MATH 8656).
Prerequisite(s)/Corequisite(s): MATH 2350/MATH 8355 and MATH 4270/MATH 8276.

MATH 4660 AUTOMATA, COMPUTABILITY, AND FORMAL LANGUAGES (3 credits)
This course presents a sampling of several important areas of theoretical computer science. Definition of formal models of computation and important properties of such models, including finite automata and Turing machines. Definition and important properties of formal grammars and their languages. Introduction to the formal theories of computability and complexity. (Cross-listed with CSCI 4660, CSCI 8666, MATH 8666)
Prerequisite(s)/Corequisite(s): MATH 2030. Recommended: CSCI 3320/ CSCI 8325.

MATH 4740 INTRODUCTION TO PROBABILITY AND STATISTICS I (3 credits)
A mathematical introduction to probability theory including the properties of probability; probability distributions; expected values and moments; specific discrete and continuous distributions; and transformations of random variables. (Cross-listed with MATH 8746).
Prerequisite(s)/Corequisite(s): MATH 1970 and either MATH 2230 or MATH 2030

MATH 4750 INTRODUCTION TO PROBABILITY AND STATISTICS II (3 credits)
Theory and methods of statistical inference including estimators, statistical hypotheses, multivariate estimation, chi-square tests, analysis of variance and statistical software. (Cross-listed with MATH 8756).
Prerequisite(s)/Corequisite(s): MATH 4740/MATH 8746

MATH 4760 TOPICS IN MODELING (3 credits)
Selection of such topics as formulation and analysis of various models involving Markov chains, Markov processes (including birth and death processes), queues, cellular automata, difference and differential equations, chaotic systems and fractal geometries. (Cross-listed with MATH 8766, CSCI 4760, CSCI 8766).
Prerequisite(s)/Corequisite(s): MATH 2350 and MATH 4740 or MATH 8746.

MATH 4900 INDEPENDENT STUDIES (1-3 credits)
A variable credit course for the junior or senior who will benefit from independent reading assignments and research-type problems. Independent study makes available courses of study not available in scheduled course offerings. The student wishing to take an independent study course should find a faculty member willing to supervise the course and then submit, for approval, a written proposal (including amount of credit) to the MATH/ STAT Undergraduate Curriculum Committee at least one week prior to registration.
Prerequisite(s)/Corequisite(s): Junior and permission of the chair

MATH 4980 SEMINAR (1-3 credits)
A seminar in mathematics.
Prerequisite(s)/Corequisite(s): At least one math course numbered 3000 or above (not including MATH 3500) and permission.

STAT 3000 STATISTICAL METHODS I (3 credits)
Distributions, introduction to measures of central value and dispersion, population and sample, the normal distribution, inference: single population, inference: two populations, introduction to analysis of variance. Statistical packages on the computer will also be utilized in the course. (Cross-listed with STAT 8005)
Prerequisite(s)/Corequisite(s): MATH 1310 or equivalent.

STAT 3010 STATISTICAL METHODS II (3 credits)
Regression and correlation, analysis of covariance, chi-square type statistics, more analysis of variance, questions of normality, introduction to non-parametric statistics. Statistical packages are used when appropriate. (Cross-listed with STAT 8015)
Prerequisite(s)/Corequisite(s): STAT 3000 or STAT 8005.

STAT 3800 APPLIED ENGINEERING PROBABILITY AND STATISTICS (3 credits)
An introduction to the application of probability and statistics to engineering problems. Topics include: probability and probability distributions, mathematical expectation, distribution of random variables, binomial, Poisson, hypergeometric, gamma, normal, and t-distributions, Central Limit Theorem, confidence intervals, hypothesis testing, linear regression, contingency tables. Credit for both MATH 4740 and STAT 3800 will not be given. (Cross-listed with STAT 8805)
Prerequisite(s)/Corequisite(s): MATH 1970

STAT 4410 INTRODUCTION TO DATA SCIENCE (3 credits)
Topics covered in this course include Data Technology, Methods of gathering and cleaning structured or unstructured data, Exploratory data analysis & Dynamic and interactive data visualization, Modeling data for prediction, forecasting or classification. (Cross-listed with STAT 8416)
Prerequisite(s)/Corequisite(s): MATH 4750 w/ a C- or better or STAT 3800 w/ a C- or better or permission of instructor. Students planning to enroll in this course should be comfortable with computer programming & have knowledge of data structures & preliminary statistical methods.

STAT 4420 EXPLORATORY VISUALIZATION AND QUANTIFICATION (3 credits)
Topics covered in this course include Exploratory Data Visualization for categorical/qualitative single/multivariate data, Grammar of Graphics, Organizing Data for Visualization, Methods of Displaying Data that include dynamic and interactive visualization, Visual Diagnostics of Statistical Models and Visual Statistical Inference. Students planning to enroll in this course should be comfortable with computer programming and have knowledge of data structures and preliminary statistical methods. (Cross-listed with STAT 8426)
Prerequisite(s)/Corequisite(s): MATH 4750 or MATH 8756 w/ a grade of C- or better or STAT 3800 or STAT 8005 w/ a C- or better or another introductory probability/statistics course w/ a C- or better, & CSCI 1620 or equivalent with a grade of C- or better, or permission of instructor.

STAT 4430 LINEAR MODELS (3 credits)
This is an introduction to linear statistical models which will include: simple linear regression models, multiple linear regression models, ANOVA models including one way ANOVA, randomized block design, and other designs. Also, logistic regression models, Poisson regression models, bootstrapping/resampling models, survival analysis. Some necessary linear algebra and mathematical statistics ideas will be covered in the course also. If time allows, some mixed models and/or survival models. Much use of computer software will be made. (Cross-listed with STAT 8436)
Prerequisite(s)/Corequisite(s): MATH 4750 or MATH 8756 w/ a C- or better or STAT 3800 or STAT 8005 w/ a C- or better or instructor permission based on students' having taken a basic statistics course w/ a grade of C- or better & having at least a basic knowledge of calculus.
STAT 4440  TIME SERIES ANALYSIS (3 credits)
The objective of this course is to learn and apply statistical methods for the
analysis of data that have been observed over time. Topics covered include:
Models for Stationary and Non-Stationary Time Series, Model Specification,
Parameter Estimation, Model Diagnostics, Forecasting, Seasonal Models,
Time Series Regression, and Spectral Analysis. Statistical software will be
used. (Cross-listed with STAT 8446)

Prerequisite(s)/Corequisite(s): MATH 4750 or MATH 8756 w/ a grade
of C- or better or STAT 3800 or STAT 8005 w/ a C- or better or another
introductory probability/statistics course w/ a C- or better, & CSCI 1620 or
equivalent with a grade of C- or better, or permission of instructor.