MATHEMATICS AND STATISTICS

About Us

The Department of Mathematics and Statistics offers a wide variety of undergraduate and graduate degree programs designed for students with diverse career or higher educational goals. The faculty assists students achieve these goals with up-to-date courses, seminars, and research or internship projects. Our faculty members maintain highly productive research programs which regularly result in publications in leading journals and academic presses. Much of the faculty research is supported by external agencies. The faculty is also actively engaged in modernizing our elementary course offerings both in content and in the use of technology.

Mission

The Department of Mathematics and Statistics at Loyola University Chicago, in the College of Arts and Sciences, supports the Jesuit ideal of knowledge in the service of humanity. The department endeavors to advance knowledge in mathematics and statistics, engaged with Chicago, the nation and the world. To achieve this mission, the department participates in the discovery, development, demonstration and dissemination of professional knowledge and practice within a context of professional ethics and service to others.

Beyond honing students' analytical skills, the mathematics and statistics curricula also foster critical thinking and the ability to articulate it... skills that are in high demand in many diverse fields.

Commitment to Diversity, Equity, and Inclusion

The Department of Mathematics and Statistics will work to ensure that we invest in each student's success, sense of belonging, and cultural competency. We will strive to engage, empower, inform, and hold our faculty and students accountable for fostering an environment where every person shares in the responsibility for advancing diversity and inclusive excellence. Likewise, the department decisions and policies will be crafted with these goals in mind. We commit to this mission recognizing a definition of diversity that includes, but is not limited to, race, ethnicity, color, religion, national or ethnic origin, sex, age, military/veteran status, disability, marital status, sexual orientation, gender identity and expression, socio-economic background, and residency.

Undergraduate Programs

- Actuarial Science Minor (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/actuarial-science-minor/)
- Applied Mathematics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/applied-mathematics-bs/)
- Biostatistics Minor (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/biostatistics-minor/)
- Data Science/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/data-science-applied-statistics-bs-ms/)
- Data Science/Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/data-science-mathematics-bs-ms/)
- Mathematics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/mathematics-bs/)
- Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-bs-ms/)
- Mathematics/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-applied-statistics-bs-ms/)
- Mathematics - Education Track (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/mathematics-education-track-bs/)
- Mathematics - Education Track/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-education-track-bs-applied-statistics-ms/)
- Mathematics - Education Track/Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-education-track-bs-mathematics-ms/)
- Mathematics and Computer Science (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/mathematics-computer-science-bs/)
- Mathematics and Computer Science/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-computer-science-bs-applied-statistics-ms/)
- Mathematics and Computer Science/Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/mathematics-computer-science-mathematics-bs-ms/)
- Mathematics Minor (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/mathematics-minor/)
- Statistics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/statistics-bs/)
- Statistics/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/statistics-applied-statistics-bs-ms/)
- Statistics/Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/statistics-bs-mathematics-ms/)
- Statistics Minor (https://catalog.luc.edu/undergraduate/arts-sciences/mathematics-statistics/statistics-minor/)
- Theoretical Physics and Applied Mathematics (BS) (https://catalog.luc.edu/undergraduate/arts-sciences/physics/theoretical-physics-applied-mathematics-bs/)
- Theoretical Physics and Applied Mathematics/Applied Statistics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/theoretical-physics-applied-mathematics-bs-applied-statistics-ms/)
- Theoretical Physics and Applied Mathematics/Mathematics (BS/MS) (https://catalog.luc.edu/undergraduate/accelerated-bachelors-masters-program/theoretical-physics-applied-mathematics-bs-mathematics-ms/)

Mathematics and Statistics Department Policies

Registration Restrictions

Students who have successfully completed (with a grade of C- or higher) any 100-level course are not permitted to take or repeat a prerequisite of such course without explicit permission from the Chair or Assistant Chair of the Department of Mathematics and Statistics. For example, a student who earned a grade of B in MATH 161 Calculus I is not permitted

to register for MATH 100 Intermediate Algebra, MATH 117 Precalculus I or MATH 118 Precalculus II.

Prerequisite Policy

A student's lack of appropriate course prerequisites constitutes **grounds for withdrawal** from the class at any time.

AP Course Credit Policies

Students may receive credit for the following courses if they earn an appropriate score on an Advanced Placement Test offered by the College Board (https://www.collegeboard.org/).

AP Calculus

Credit for the AP Calculus exams will be awarded as follows:

- 4–5 on AB Calculus Exam 4 credits for MATH 161 Calculus I;
- 4–5 on BC Calculus Exam 8 credits for MATH 161 Calculus I and MATH 162A Calculus II, Alternate;
- 4–5 on AB portion of BC Calculus Exam 4 credits for MATH 161 Calculus I.

AP Statistics

A score of 4 or 5 results in credit for STAT 103 Fundamentals of Statistics.

Policy on Multiple Majors or Minors

The following modifies and clarifies the "Double-Dipping" policy (https://www.luc.edu/cas/double-dippingpolicy/) of the College of Arts & Sciences, as it pertains to the Department of Mathematics & Statistics.

Most combinations of majors or minors are allowed. In particular, combinations of majors will be permitted as long as students respect the College of Arts & Sciences policy that each major should include 21 credit hours not being counted for another major, along with the following restrictions specific to the Department of Mathematics & Statistics:

1. MATH-BS *may* be paired with TPAM-BS, but **may not** be earned together with a *double-major* in TPAM-BS plus any Physics major (*e.g.*, BPHY-BS, PCSC-BS, PHYS-BS)
2. MATH-BS *may* be paired with MSCS-BS, but **may not** be earned together with a *double-major* in MCSC-BS plus any Computer Science major.
3. DSCI-BS *may* be paired with either STAS-BS or a computer science major, but not with a double major in statistics and computer science.

All Minors offered by the department must contain at least 6 credit hours at the 200 level or above not used to satisfy requirements of any other major or minor, and at least three of these must be at the 300 level. This condition may be met by taking additional electives, if necessary, from the electives list for the minor. Furthermore, the following combinations are not allowed. All other combinations are allowed provided they meet the above criteria

- ACTU-MINR **may not** be earned together with STAS-BS or DSCI-BS
- BIOS-MINR **may not** be earned along with STAS-BS or DSCI-BS
- MATH-MINR **may not** be earned together with AMTH-BS, MATH-BS, MCSC-BS, MTED-BS, TPAM-BS
- STAT-MINR **may not** be earned together with STAS-BS. STAT-MINR **may** be earned with DSCI-BS but **only** if STAT 304 Introduction to Probability and STAT 305 Introduction to Mathematical Statistics are taken as electives.
- DSCI-MINR **may not** be earned along with DSCI-BS or a double major with STAS-BS and any computer science major.

Policy on students who fail a class repeatedly

Any student wishing to enroll in a math or stats class who has failed that class twice previously (with grades of D+ or lower) must obtain permission from the department. For students who have failed exactly twice permission can be obtained from the course coordinator or, for un-coordinated classes, from the undergraduate program director. For students who have failed three or more times permission is needed from the department chair. Permission will only be given if there is good reason to believe you can be successful with an additional attempt at the class.

Performance Withdrawal Policy

A student **may be withdrawn from any of our majors** if:

1. The student receives 2 grades less than C- in a two-year period in courses required for the major, or
2. The student has a GPA in the major < 2.0 after completion of all 100-level and 200-level requirements.
3. The chair has the right to reinstate students in the major for exceptional cases.

Requirements for Departmental Honors

In order to receive departmental honors, students graduating with any major (https://www.luc.edu/math/undergradprogs.shtml/) offered by the Department of Mathematics and Statistics must satisfy the following two criteria:

- Minimum 3.5 GPA for all program-required courses, at 200-level and higher;
- Have taken an extra 3-credit course, beyond major requirements(*), chosen from:
  - A standard MATH/STAT offering at 300-level or above
  - MATH/STAT 398
  - EXPL 391 (supporting a joint project with a department faculty member)

Interested students are encouraged to discuss this honor with their departmental academic advisor or the department chair. However, no application is required, as a full graduation audit will be conducted by the Awards Committee each year.

(*) In most cases this extra course may also be used to count towards another major or minor. So, for example, if you are pursuing a Math major and a Stats minor your 300-level Stats elective could fulfill this requirement. Please check with your department advisor if you are unsure.

Undergraduate Policies and Procedures

Please see Undergraduate Policies and Procedures (https://catalog.luc.edu/academic-standards-regulations/undergraduate/) for academic policies that supersede those of academic units within the University.

Mathematical Sciences (MATH)

MATH 100 Intermediate Algebra (3 Credit Hours)
Pre-requisites: Math Placement Test
This course covers the fundamentals of algebra, ranging from linear equations and their graphs through exponents and systems of equations.
Course equivalencies: ACMAT100/MATH100
Outcomes:
Students will receive the preparation needed to use algebra in other courses or, if they plan to take calculus, to enroll in Precalculus I

MATH 108 Real World Modeling with Mathematics (3 Credit Hours)
This course investigates mathematical modeling applied to a variety of topics such as linear programming, coding information, probability and statistics, scheduling problems and social choice.
Knowledge Area: Quantitative Knowledge
Outcomes:
Students will understand the usefulness of mathematical modeling in a variety of disciplines within the life sciences, the social sciences, and business; This course satisfies the quantitative literacy requirement of the core curriculum

MATH 110 Business Precalculus (3 Credit Hours)
Pre-requisites: (MATH100 or math placement of MATH117 or above) AND (Declared major in the Quinlan School of Business OR the ECON-BA Major)
A one-semester course in precalculus designed for business students. It includes the study of functions, their graphs, and their basic properties. Techniques for solving equations involving linear, quadratic, polynomial, exponential and logarithmic functions are explored, and ideas like inverse functions are developed. An emphasis is placed on business applications.
Outcomes:
Students will be able to work with and analyze polynomial, logarithmic and exponential functions using a variety of techniques and apply those skills in a variety of contexts, especially business applications

MATH 117 Precalculus I (3 Credit Hours)
Pre-requisites: Math Placement Test or MATH 100
This course covers a variety of algebraic topics, including functions and their applications, graph transformations, composition and inverse functions, as well as polynomial and rational functions.
Course equivalencies: ACMAT 117/MATH 117
Outcomes:
Students who plan to study calculus will obtain the algebraic background needed to enroll in Precalculus II

MATH 118 Precalculus II (3 Credit Hours)
Pre-requisites: Math Placement Test or MATH 117
This course covers topics ranging from exponential and logarithmic functions to trigonometric functions. It also considers applications of these topics in various settings.
Course equivalencies: MATH 118/ ACMAT 118
Outcomes:
Students will obtain the background needed to enroll in either of the department's calculus sequences

MATH 123 Topics (1-3 Credit Hours)
Freshman Mathematics/Statistics Seminar (1-3 Credit Hours): A freshman seminar with no prerequisites on topics in the mathematical sciences drawn from algebra, geometry, statistics, and their applications.

MATH 130 Business Calculus (4 Credit Hours)
Pre-requisites: (MATH110 or MATH118 or math placement of MATH131 or 161) AND (Declared major in the Quinlan School of Business OR the ECON-BA Major)
An introduction to calculus focused on business applications. The following topics are considered: modeling change using algebraic, exponential and logarithmic functions, derivatives, optimization, integration, functions of two variables, and partial derivatives.
Outcomes:
Students will understand and be able to use methods of calculus (especially differential calculus) and be able to apply these in a variety of contexts, especially business applications

MATH 131 Applied Calculus I (3 Credit Hours)
Pre-requisites: Math Placement Test or MATH 118
An introduction to differential and integral calculus, with an emphasis on applications. This course is intended for students in the life and social sciences, computer science, and business. Topics include: modeling change using functions including exponential and trigonometric functions, the concept of the derivative, computing the derivative, applications of the derivative to business and life, social and computer sciences, and an introduction to integration.
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will obtain an understanding of calculus and methods for applying calculus (especially differential calculus), including modeling/analyzing processes (such as population growth and cooling), interpreting the derivative (numerical, graphical, and algebraic), and optimization (such as finding the time and level for a peak drug concentration)

MATH 132 Applied Calculus II (3 Credit Hours)
Pre-requisites: MATH 131
This course is a continuation of MATH 131. Topics include: definition and interpretations of the integral (numerically, graphically, and algebraically), basic techniques for computing anti-derivatives, applications to probability, an introduction to multi-variable calculus and optimization for functions of several variables, and mathematical modeling using differential equations. (This course is not a substitute for MATH 162.)
Interdisciplinary Option: Bioinformatics, Forensic Science
Outcomes:
Students will obtain an understanding of integral and multi-variable calculus, including modeling/analyzing processes with the integral, optimization of functions of several variables, and modeling with differential equations

MATH 140L Geometry for Middle Grade Teachers (3 Credit Hours)
The content covered in this course will include: Area, perimeter, volume, surface area, Properties of two and three dimensional figures, points, lines, planes, space, the Pythagorean theorem, transformations, fractals, tessellations, perspective drawings and informal proofs. The material covered will address Illinois Learning Standard Goal 7 and Goal 9 and related content performance descriptors for educators. The course is designed for Elementary education majors that wish to enhance, enrich and deepen their knowledge of Geometry and apply for a 6th-8th grade Mathematics endorsement from the State of Illinois. Mathematics Content Area Standards 7 (Measurement) and 9 (Geometry) from the Content-Area Standards for Educators document published by the Illinois State Board of Education will be emphasized.
Outcomes:
Students will obtain an understanding of the geometry topics taught in the middle grade mathematics curriculum

MATH 141L Number Theory for Middle Grade Teachers (3 Credit Hours)
Greatest common divisors, prime factorization, decimal fractions, continued fractions, primes, composite numbers, tests for divisibility, perfect numbers, polygonal numbers, numbers bases, and patterns in addition and multiplication tables are a sample of the topics covered. (Illinois Learning Standard Goal 6 and related performance descriptors). Appropriate use of technology (spread sheets, CAS, etc.) will also be addressed.
Outcomes:
Students will obtain an understanding of topics from Number Theory that are addressed in the middle grade mathematics curriculum

MATH 142L History of Mathematics for Middle Grade Teachers (3 Credit Hours)
This course will provide a thematic approach to the history of mathematics with emphasis on contributions by noted mathematicians, mathematical societies and scientists highlighting women and under-represented populations. The history of numbers and numerals, computation, geometry, algebra, trigonometry, calculus, and science patterns will be explored emphasizing the contributions of the Babylonian, Egyptian, Chinese, and Roman civilizations as well as such individuals as Euclid, Fermat, Archimedes, Kepler, Pythagoras, Euler, Hypatia, Sonjs Kovalevsky, Emmy Noether and others as appropriate. The influence of technology and its applications will also be presented as appropriate.
Outcomes:
Students will obtain a unique historical perspective on the various areas of mathematics that are studied in the middle grade mathematics curriculum

MATH 143L Probability and Statistics for Middle Grade Teachers (3 Credit Hours)
Data collection and display, simulations, surveys, probability and elementary statistics such as mean, median, mode, standard deviation, etc. will be the focus of this course (Illinois Learning Standard Goal 10) Appropriate techniques for graphing (scatter plots, histograms, regression, correlation) with and without technology will be a focus of this course.
Outcomes:
Students will obtain a background in the fundamentals of descriptive and inferential statistics, along with an understanding of their uses and misuses, as addressed in middle school mathematics curriculum

MATH 147 Mathematics For Teachers I (3 Credit Hours)
For course description, see CIEP 104.
This course satisfies the Engaged Learning requirement.
Course equivalencies: X-CIEP104/MATH147

MATH 148 Mathematics For Teachers II (3 Credit Hours)
For course description, see CIEP 105.
Course equivalencies: X-CIEP105/MATH148

MATH 149 Intro to Computer Science For Teachers (3 Credit Hours)
For prerequisite and description, see COMP 120.
Course equivalencies: X-COMP120/MATH149

MATH 161 Calculus I (4 Credit Hours)
Pre-requisites: Math Placement Test or MATH 118
This course provides a standard introduction to differential and integral calculus and covers topics ranging from functions and limits to derivatives and their applications to definite and indefinite integrals and the fundamental theorem of calculus and their applications.
Interdisciplinary Option: Bioinformatics, Forensic Science
Course equivalencies: ACMAT 161/MATH 161
Outcomes:
Students will obtain a theoretical understanding of principles of differential and integral calculus, will demonstrate computational skills in support of reasoning and interpretation, and will apply concepts such as the derivative and the integral to modeling processes; Students will be able to make use of a wide variety of techniques of differentiation

MATH 162 Calculus II (4 Credit Hours)
Pre-requisites: MATH 161
This course is a continuation of Calculus I and includes the calculus of various classes of functions, techniques of integration, applications of integral calculus, three-dimensional geometry, and differentiation and integration in two variables.
Interdisciplinary Option: Bioinformatics
Course equivalencies: ACMAT 162/MATH 162
Outcomes:
Students will obtain an understanding of techniques for finding anti-derivatives, and applications of the integral to questions in three-dimensional geometry and physics; Students will obtain conceptual understanding about functions of several variables and apply these concepts to optimization and integration questions for functions of two variables; Students will employ techniques for solving differential equations and their applications

MATH 162A Calculus II, Alternate (4 Credit Hours)
Pre-requisites: MATH 161
This course is a continuation of Calculus I and includes the calculus of various classes of functions, techniques of integration, applications of integral calculus, sequences and infinite series, and an introduction to differential equations. This course follows a traditional approach to calculus sequencing.
Interdisciplinary Option: Bioinformatics
Outcomes:
Students will obtain the background needed for further study in mathematics and to apply mathematics in the physical sciences

MATH 170 Service Learning in Mathematics (3 Credit Hours)
Pre-requisites: B+ or higher in any of the following (MATH 118 or MATH 131 or MATH 132 or MATH 161 or MATH 162 or MATH 263 or MATH 263A)
Students will learn best practices to communicate mathematical concepts and skills to diverse populations by engaging in tutoring mathematics to the undergraduate population at Loyola. This course is designed to promote and encourage engagement and rigor in mathematical concepts and skills among the diverse communities of learners at Loyola.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students in this course will deepen their understanding of mathematical concepts and skills and be able to communicate this effectively to diverse communities of learners

MATH 201 Introduction to Discrete Mathematics & Number Theory (3 Credit Hours)
Pre-requisites: MATH 161
This course covers topics from discrete mathematics and number theory, areas of mathematics not seen in calculus courses and abundant in applications, that provide students with the concepts and techniques of mathematical proof needed in 300 level courses in mathematics.
Outcomes:
Students will obtain an understanding of the basic concepts and techniques involved in constructing rigorous proofs of mathematical statements

MATH 212 Linear Algebra (3 Credit Hours)
Pre-requisites: MATH 132 or MATH 162 or MATH 162A
This course provides an introduction to linear algebra in abstract vector spaces with an emphasis on Rn, covering topics such as Gaussian elimination, matrix algebra, linear independence and spanning, linear transformations and eigenvalues; software packages such as MAPLE may be used.
Outcomes:
Students will receive an introduction to abstract mathematics in a setting that encourages the thinking needed in more advanced mathematics courses

MATH 215 Object-Oriented Programming with Mathematics (3 Credit Hours)
Pre-requisites: MATH 132 or MATH 162 or MATH 162A
This is an introductory programming course for students interested in mathematics and scientific computing. Students will program primarily in a general object-oriented language such as Python, with supplementary exercises in a computer algebra system. Examples will be drawn primarily from applications of calculus, elementary number theory, and cryptography.
Course equivalencies: X-COMP215/MATH215
Outcomes:
Students will learn basic scripting and object-oriented programming, with the goal of being able to solve mathematical and scientific problems

MATH 263 Multivariable Calculus (4 Credit Hours)
Pre-requisites: MATH 162
This course covers the differential and integral calculus of multivariable and vector valued functions, and sequences and infinite series, culminating with Green's Theorem, the Divergence Theorem, and Stokes' Theorem.
Outcomes:
Students will obtain an understanding of multivariable calculus and its applications, as well as background needed for the study of more advanced mathematics

MATH 263A Multivariable Calculus, Alternate (4 Credit Hours)
Pre-requisites: MATH 162A
This course covers the differential and integral calculus of multivariable and vector valued functions, culminating with Green's Theorem, the Divergence Theorem, and Stokes' Theorem. This course follows a traditional approach to calculus sequencing.
Outcomes:
Students will obtain an understanding of multivariable calculus and its applications, as well as background needed for the study of more advanced mathematics

MATH 264 Ordinary Differential Equations (3 Credit Hours)
Pre-requisites: MATH 263 or MATH 263A (Can also be a corequisite)
This course covers the theory, solution techniques, and applications surrounding linear and non-linear first- and second-order differential equations, including systems of equations.
Outcomes:
Students will obtain an understanding of elementary differential equations and their applications

MATH 266 Differential Equations and Linear Algebra (3 Credit Hours)
Co-requisites: MATH 263 or MATH 263A
This course provides an introduction to basic topics in ordinary differential equations and linear algebra. Topics include first and second-order differential equations, Laplace transform, systems of first-order differential equations, systems of linear algebraic equations, matrix algebra, bases and dimension for vector spaces, linear independence, linear transformations, determinants, eigenvalues, and eigenvectors. Prerequisites or
Outcomes:
Students will learn fundamental results and methods in ordinary differential equations and linear algebra, with a strong emphasis on topics that are particularly relevant for Engineering Science

MATH 277 Problem-Solving Seminar (1 Credit Hour)
In a seminar setting, students discuss and present proofs (or computer examples) as solutions to regional and national mathematics contest problems usually involving techniques drawn from elementary logic, calculus of one and several variables, combinatorics, number theory, geometry, basic algebra, and abstract algebra. Learning Outcome: To improve a student's ability to communicate mathematically and to strengthen the student's problem-solving skills.

MATH 298 Research Seminar in Mathematics (1 Credit Hour)
Pre-requisites: MATH 162 or MATH 162A
A seminar-style course that covers various topics about how to conduct research in mathematical sciences while engaging students in active research projects with faculty mentors.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students will obtain an initial insight into a number of areas of advanced study in mathematics

MATH 301 History of Mathematics (3 Credit Hours)
Pre-requisites: MATH 132 or MATH 162 or MATH 162A
This course explores selected topics in the history of mathematics ranging from Babylonian and Egyptian mathematics to Pythagoras and Euclid to the Hindu-Arabic numeration system to Newton and Leibniz to geometries other that Euclid's to the mathematical art of Escher.
Outcomes:
Students will obtain a unique historical perspective on the various areas of mathematics that they are studying in their other courses

MATH 304 Introduction to Probability (3 Credit Hours)
For prerequisites and description, see STAT 304.
Course equivalencies: X-MATH304/STAT304

MATH 305 Introduction to Mathematical Statistics (3 Credit Hours)
For prerequisites and description, see STAT 305.
Course equivalencies: X-MATH305/STAT305

MATH 306 Intro to Stochastic Processes (3 Credit Hours)
For prerequisites and description, see STAT 306.
Course equivalencies: X-MATH306/STAT306

MATH 309 Numerical Methods (3 Credit Hours)
Pre-requisites: (COMP 170 or COMP 215) and [(MATH 212 and MATH 264) or MATH 266]
An introduction to numerical techniques for solving mathematical problems where exact solutions are impractical or computationally intensive. Topics include numerical errors, root finding, interpolation and approximation, solutions to systems of linear equations, numerical differentiation and integration, numerical solutions to ordinary and partial differential equations equations, and other selected topics.
Course equivalencies: X-COMP309/MATH309
Outcomes:
Students will obtain an understanding of how numerical methods can be used in a variety of areas of mathematics

MATH 313 Abstract Algebra (3 Credit Hours)
Pre-requisites: MATH 201 and 212
This course provides a rigorous introduction to the study of structures such as groups, rings, and fields; emphasis is on the theory of groups with topics such as subgroups, cyclic groups, Abelian groups, permutation groups, homomorphisms, cosets, and factor groups.
Outcomes:
Students will be able to read, understand, and communicate arguments about group theory and abstract algebraic structures, preparing them for further advanced work in mathematics

MATH 314 Advanced Topics Abstract Algebra (3 Credit Hours)
Pre-requisites: MATH 313
This course studies advanced algebraic systems with an emphasis on rings and fields, culminating with the Galois theory of equations.
Outcomes:
Students will be able to read, understand, and communicate arguments about rings, fields and abstract algebraic structures, preparing them for further advanced work in mathematics

MATH 315 Advanced Topics in Linear Algebra (3 Credit Hours)
Pre-requisites: MATH 313
This course offers a rigorous abstract approach to vector spaces and transformations, including similarity, duality, canonical forms, inner products, bilinear forms, Hermitian and unitary spaces, and other selected topics.
Outcomes:
Students will obtain an understanding of advanced linear algebra structures that will prepare them for graduate level work in mathematics and industry work involving mathematics

MATH 318 Combinatorics (3 Credit Hours)
Pre-requisites: MATH 162 or MATH 162A
This course offers a rigorous introduction to combinatorics, including topics such as induction, the pigeon-hole principle, permutations, combinations, recurrence relations, generating functions, the inclusion-exclusion principle, and other selected topics.
Outcomes:
Students will obtain an understanding of the basic topics in combinatorics that will prepare them for advanced study of related topics in mathematics and computer science

MATH 320 Mathematical Logic (3 Credit Hours)
Pre-requisites: MATH 201
This course in modern mathematical logic begins with a study of propositional logic and leads to the study of first-order predicate logic, including quantifiers, models, syntax, semantics, the completeness and compactness theorems, and other selected topics.
Outcomes:
Students will develop a fuller understanding of mathematical logic and therefore of the underlying theory behind proofs of mathematical assertions

MATH 322 Advanced Number Theory (3 Credit Hours)
Pre-requisites: MATH 201
This course will cover Pythagorean triples, problems related to Fermat's Last Theorem, Pell's equation, Fermat's method of descent, primes in arithmetic progressions, Mersenne primes, perfect numbers, primitive roots, primality testing, Carmichael numbers, RSA public key encryption, quadratic residues, and quadratic reciprocity. Additional topics will be covered as time permits.
Outcomes:
Students will be able to solve important practical and theoretical number theory problems; Students will be exposed to both significant recently solved number theory problems and currently unsolved conjectures

MATH 328 Algebraic Coding Theory (3 Credit Hours)
Pre-requisites: MATH 212 or MATH 266
Codes with algebraic structure for error control are examined. Block codes including Hamming codes and Reed-Muller codes, BCH codes, and other cyclic codes and their implementation are treated. Other topics may include: convolutional codes, efficiency considerations, and Shannon's fundamental theorem of information theory.
Course equivalencies: X-MATH328/COMP328

MATH 331 Cryptography (3 Credit Hours)
Pre-requisites: Theoretical Foundations: MATH201 or COMP363; Programming Foundations: COMP125 or COMP150 or COMP170 or COMP/MATH 215
This course introduces the formal foundations of cryptography and also investigates some well-known standards and protocols, including private and public key cryptosystems, hashing, digital signatures, RSA, DSS, PGP, and related topics.
Course equivalencies: X-COMP331/MATH331
Outcomes:
Students will gain an understanding of cryptosystems widely used to protect data security on the internet, and be able to apply the ideas in new situations as needed

MATH 344 Geometry (3 Credit Hours)
Pre-requisites: MATH 212
This course discusses axiomatic systems which define geometries and includes topics from synthetic and analytic projective geometry.
Outcomes:
Students will obtain an understanding of the many different geometries that are studied by teachers and researchers

MATH 345 Introduction to Financial Mathematics Derivatives (3 Credit Hours)
Pre-requisites: (MATH 264 or MATH 266) and MATH 304
The course provides an introduction to the mathematical theory of option pricing. We will rigorously derive option relationships using no arbitrage conditions, introduce rudimentary stochastic calculus and Brownian motion as models for stock prices, and give an introduction to methods for solving partial differential equations to give explicit Black-Scholes formulas.
Outcomes:
The students will gain knowledge of the theory of options, bond and stock pricing, portfolio optimization, and will be exposed to other relevant applications of Mathematics to Finance

MATH 351 Introduction to Real Analysis I (3 Credit Hours)
Pre-requisites: MATH 201 and (MATH 263 or MATH 263A) and (MATH 212 or MATH 266)
An introduction to the topology of, and to the functions on the real line or more general metric spaces. Topics include sequences, including sequences of functions, completeness, compactness, continuity, uniform continuity, and differentiation.
Outcomes:
Students will obtain an understanding of the fundamentals of real analysis that will prepare them for advanced work in mathematics

MATH 352 Introduction to Real Analysis II (3 Credit Hours)
Pre-requisites: MATH 351
A continuation of MATH 351. Topics include Riemann integration, series, including series of functions, and select topics in continuity and differentiation of multivariable functions, fixed point, implicit and inverse function theorems.
Outcomes:
Students will obtain an understanding of topics in advanced analysis that will prepare them for graduate level work in mathematics

MATH 353 Introduction to Complex Analysis (3 Credit Hours)
Pre-requisites: (MATH 264 and MATH 266) and MATH 351
An introduction to the algebra and geometry of complex numbers, topology of the complex plane, and the theory of functions of a complex variable, including: analytic functions, contour integrals, the Cauchy integral formula, harmonic functions, Laurent series, residues and poles, the Fundamental Theorem of Algebra, and other selected topics.
Outcomes:
Students will obtain an understanding of the fundamentals of complex analysis that will prepare them for advanced work in mathematics

MATH 355 Methods of Applied Mathematics (3 Credit Hours)
Pre-requisites: MATH 264
Vector calculus, linear transformations, matrices, series solutions of differential equations, special functions; Fourier series, Fourier and Laplace transforms; Partial differential equations and topics from complex analysis, Green's functions, integral equations, the calculus of variations.
Course equivalencies: X-PHYS301/PHYS271/MATH355
Outcomes:
Facility with mathematical methods used in sciences and engineering

MATH 356 Introduction to Mathematical Modeling (3 Credit Hours)
Pre-requisites: MATH 266 or (MATH 264 and MATH 212)
This course will teach students how to use various areas of mathematics, such as vector calculus, linear algebra, and/or differential equations, to formulate and analyze mathematical models in, for example, mechanics, physics, biology, economics, etc.
Outcomes:
Students will learn how to use the tools from previous mathematics classes to formulate models of real world phenomena

MATH 358 Introduction to Optimization (3 Credit Hours)
Pre-requisites: (MATH 162 or MATH 263A) and (MATH 212 or MATH 266)
The course is an introduction to linear, nonlinear, and integer optimization, and may include optimization on graphs, stochastic optimization, etc. Modeling of real-life problems as optimization problems, mathematical analysis of resulting optimization problems, and computational approaches to solving the problems will be covered.
Course equivalencies: X-MATH358/STAT358
Outcomes:
Students will learn how to recognize optimization problems, model real-life challenges as optimization problems, perform mathematical analysis of the problems, and solve the problems using computational tools

MATH 360 Introduction to Game Theory (3 Credit Hours)
Pre-requisites: MATH 162 or MATH 162A
The noncooperative and cooperative theories of games. Two person zero sum matrix games, nonzero sum N-person games, Nash equilibria of games with a continuum of strategies, auctions, duels. Cooperative game theory, including the theory of bargaining, the theory of fair allocation of rewards using the nucleolus and using the Shapley value.
Outcomes:
Students will obtain an understanding of the fundamentals of mathematical game theory and will be able to apply this knowledge in a variety of settings

MATH 365 Introduction to Partial Differential Equations (3 Credit Hours)
Pre-requisites: MATH 264 or MATH 266
This course provides an introduction to basic topics in partial differential equations (PDE). In addition to first order PDE, such as the transport equation, the main types of second order PDE, including the Laplace equation, the heat equation, and the wave equation, will be studied in detail.
Outcomes:
Students will learn fundamental results and methods in partial differential equations and their applications

MATH 366 Applied Dynamical Systems (3 Credit Hours)
Pre-requisites: MATH 266 Linear Algebra and Differential Equations
or (MATH 264 Ordinary Differential Equations and MATH 212 Linear Algebra)
Modeling, analysis, and prediction of short-term and asymptotic behavior of dynamical systems is studied. Continuous-time and discrete-time dynamical systems are considered, and modeled by differential and difference equations, respectively. Motivation comes from biological, chemical, mechanical, and engineering systems. Students will learn how to model dynamical systems and predict their behavior.

MATH 376 Formal Language & Automata (3 Credit Hours)
Pre-requisites: COMP 163 or MATH 201 or MATH 212 or MATH 266
This course introduces formal language theory, including such topics as finite automata and regular expressions, pushdown automata and context-free grammars, Turing machines, undecidability, and the halting problem.
Course equivalencies: X-COMP376/MATH376
Outcomes:
An understanding of the theoretical underpinnings of computability and complexity in computer science

MATH 386 Introduction to Topology (3 Credit Hours)
Pre-requisites: MATH 201 and 212 This first course in topology discusses topological spaces, continuity, connectedness and path-connectedness, compactness, product spaces, quotient spaces, metric spaces, countability and separation axioms, and other selected topics
No course description is available
Outcomes:
Students will obtain a background in topology that will allow them to apply this topic to other areas of mathematics or to pursue graduate studies

MATH 388 Special Topics in Mathematics (1-3 Credit Hours)
This course covers advanced topics in mathematics, including analysis, topology, algebra, applied mathematics, and logic.
Outcomes:
Students will obtain an understanding of an advanced topic in their major

MATH 390 Advanced Research Seminar in Mathematics (2 Credit Hours)
Pre-requisites: MATH 304/STAT 304 or MATH 313 or MATH 351
The seminar will cultivate students' presentation skills through participation in and critical discussion of brief lectures on familiar and unfamiliar topics; preparation and presentation of two brief lectures by the student (one on a familiar topic from the curriculum, one on a higher level material not customarily from the curriculum); and preparation of an extended abstract summarizing the advanced material presented.
Outcomes:
Students will gain the ability to present material in Mathematics and applications to a general audience

MATH 395 Capstone Seminar (3 Credit Hours)
Pre-requisites: MATH 313 Abstract Algebra, MATH 351 Introduction to Real Analysis I, and MATH 390 Undergraduate Seminar
The course unifies the knowledge gained in previous Mathematics courses and provides an opportunity for in-depth study and presentation of advanced material not usually covered in the standard Mathematics curriculum.
Outcomes:
Students will learn how to integrate previous knowledge in exploring new topics in Mathematics, discover applications to other disciplines, and refine their mathematical writing and presentation skills

MATH 398 Independent Study (1-6 Credit Hours)
This course allows students to engage in independent study on selected topics in mathematics under the supervision of a faculty member.
Outcomes:
Students will obtain an understanding of an advanced topic in their major

Statistics (STAT)

STAT 103 Fundamentals of Statistics (3 Credit Hours)
This course provides an introduction to statistical reasoning and techniques in descriptive and inferential statistics and their applications in economics, education, genetics, medicine, physics, political science, and psychology. Not open to students who have completed ISOM 241.
Knowledge Area: Quantitative Knowledge
Course equivalencies: ISSCM/H/241/STAT103/ACST101/03
Outcomes:
Students will obtain a background in the fundamentals of descriptive and inferential statistics along with an understanding of their uses and misuses; This course satisfies the quantitative literacy requirement of the core curriculum

STAT 203 Introduction to Probability & Statistics (3 Credit Hours)
Pre-requisites: MATH 132 or MATH 162 or MATH 162A; MATH 162 may also be taken concurrently as a co-requisite
This course is a Calculus-based rigorous introduction to basic topics in probability (distributions, expectations, variance, central limit theorem and the law of large numbers) and statistics (estimation, hypothesis testing, regression, design of experiments) needed in engineering and science applications.
Outcomes:
Students will obtain required knowledge in probability and statistics useful in every area of engineering and science; They will learn how to assess data and outcomes of experiments

STAT 303 SAS Programming & Applied Statistics (3 Credit Hours)
Pre-requisites: STAT 103 or 203 or 335
This course provides an introduction to SAS programming in the context of practical problems taken from applied statistics.
Outcomes:
Students obtain extensive experience with data-set manipulations, SAS procedures, and their application in contexts such as t-tests, simple and multiple regression, ANOVA, and regression

STAT 304 Introduction to Probability (3 Credit Hours)
Pre-requisites: MATH 263 or MATH 263A
This course provides a calculus based introduction to probability theory, including topics such as combinatorial analysis, conditional probability, and a variety of statistical distributions.
Course equivalencies: X-MATH304/STAT304
Outcomes:
Students obtain the theoretical background in probability needed for further study in probability and statistics

STAT 305 Introduction to Mathematical Statistics (3 Credit Hours)
This course is a continuation of STAT 304 and applies the techniques of calculus and probability to the study of advanced topics in statistics.
Course equivalencies: X-MATH305/STAT305
Outcomes:
Students obtain the theoretical background in statistics needed for graduate level work in probability and statistics

STAT 306 Intro to Stochastic Processes (3 Credit Hours)
Pre-requisites: (STAT 203 or STAT 335) and (MATH 212 or MATH 266)
This course discusses topics such as finite-state Markov processes and Markov chains, classification of states, long-run behavior, continuous time processes, birth and death processes, random walks, and Brownian motion.
Course equivalencies: X-MATH306/STAT306
Outcomes:
Students will obtain a background in stochastic processes that will allow them to apply them in areas like genetics, population growth, inventory, cash management, and gambling theory

STAT 307 Statistical Design & Analysis of Experiments (3 Credit Hours)
Pre-requisites: (STAT 203 or STAT 335 with a C- or better) and STAT 308 with a C- or better
This course discusses comparative experiments, analysis of variance and covariance, fixed and random effects models, and a variety of experimental design models including cross-over and split plot designs; contemporary statistical software will be used extensively.
Outcomes:
Students will obtain the background in statistical design and analysis of experiments needed to apply them in their own areas of interest

STAT 308 Applied Regression Analysis (3 Credit Hours)
Pre-requisites: STAT 203 or 335
This course discusses simple and multiple linear regression methods, multiple comparison estimation procedures, residual analysis, and other methods for studying the aptness of a proposed regression model; contemporary statistical software will be used extensively.
Outcomes:
Students will obtain an extensive background in the applications of regression analysis and computer coding of regression models

STAT 310 Categorical Data Analysis (3 Credit Hours)
Pre-requisites: (STAT 203 or STAT 335) and (STAT 303 or STAT 308)
An introduction to modern-day extensions of simple linear regression and ANOVA to the chi-square test including logistic regression and log-linear modelling techniques based on generalized linear models. Methods for matched-pair, small datasets, ordinal and multi-category data also discussed. This course focuses on applications using real-life data sets, and uses popular software packages.
Outcomes:
Students will obtain an extensive background in the applications of categorical data analysis methods

STAT 311 Applied Survival Analysis (3 Credit Hours)
Pre-requisites: STAT 308 (Applied Regression Analysis)
This course focuses on methods for analyzing time-to-event data. The course will explore non-parametric methods for analyzing time-to-event data like Life tables, the Kaplan-Meier method, the Nelson-Aalen method and the log-rank test. This course will also explore semi-parametric models such as the Cox proportional hazards regression models and parametric models including exponential, Weibull and log-logistic regression model.
Outcomes:
Derive survival and hazard functions from an underlying distribution, calculate survival probabilities and hazard rates, compare survival probabilities and hazard ratios between two or more cohorts

STAT 321 Computational Aspects of Modeling and Simulation (3 Credit Hours)
Pre-requisites: STAT 308
This course uses SAS and R languages to address statistical modelling and to conduct statistical simulations to assess linear, generalized linear, nonlinear and complex models and experimental designs.
Course equivalencies: X-STAT356/COMP321/STAT321
Outcomes:
Students will gain practical experience and knowledge in real-world statistical situations for which underlying theory is cumbersome or intractable

STAT 335 Introduction to Biostatistics (3 Credit Hours)
Pre-requisites: BIOL 102 and (MATH 132 or MATH 162 or MATH 162A (MATH 162 may be taken as a pre- or co-requisite))
For Bioinformatics Majors only: BIOL 101 and (MATH 132 or MATH 162 or MATH 162A (MATH 162 may be taken as a pre- or co-requisite)). This course provides an introduction to descriptive and inferential statistics in the biological sciences. Topics include data visualization, probability, discrete and continuous probability distributions, confidence intervals, t-tests, tests of proportions, chi-square tests, correlation, linear regression and ANOVA. Contemporary computer software will be used to apply the methods.
Interdisciplinary Option: Bioinformatics, Forensic Science
Course equivalencies: X-BIOL335/STAT335
Outcomes:
Students will be able to visualize data appropriately, to properly design a statistical experiment, to apply the correct statistical methods and properly analyze the results

STAT 336 Advanced Biostatistics (3 Credit Hours)
Pre-requisites: STAT 203 or STAT 335
This course overviews applied statistical methods useful in biomedical modelling chosen from: experimental design, categorical data analysis including logistic regression, nonlinear regression, bioassay and synergy modelling, multivariate methods, survival statistics, and longitudinal data analysis techniques. Modern statistical software methods will be extensively used and illustrated.
Course equivalencies: X-STAT336/BIOL336
Outcomes:
Students are expected to obtain expertise in applying this course's advanced biostatistical methods application areas including knowing how best to implement these methods, interpret results, and use statistical software output

STAT 337 Quantitative Methods in Bioinformatics (3 Credit Hours)
Pre-requisites: STAT 203 or 335
This course develops the mathematical and statistical methods necessary to analyze and interpret genomic and proteomic data, including signal analysis, sequence alignment methods, data-base search methods useful in bioinformatics and data mining.
Interdisciplinary Option: Bioinformatics
Course equivalencies: XSTAT337/BIOL337/BIOI337
Outcomes:
Students will obtain the quantitative skills used in BLAST, including inference, stochastic processes and hidden Markov models, random walks, microarray analysis and biological sequence analysis

STAT 338 Predictive Analytics (3 Credit Hours)
Pre-requisites: STAT 308
Students will study methods for predicting future events and properly classifying data using both supervised and unsupervised statistical learning techniques.
Outcomes:
Learn methods for predicting and classifying; Model Selection; Evaluate the effectiveness and accuracy of a model/prediction

STAT 344 Longitudinal Data Analysis and Mixed Modelling (3 Credit Hours)
Pre-requisites: (STAT 203 or STAT 335 with a C- or better) and STAT 308 with a C- or better or permission of the instructor
Repeated measures and longitudinal data are ubiquitous in studies, research and applications. This course explores methods for repeated measures, longitudinal (time-series), and nested/hierarchical data in a detailed manner. These methods take account of correlations between measurements by allowing each individual in a study to serve as their own control.
Outcomes:
Students are expected to master the analysis and interpretation of repeated measures, longitudinal, mixed, and nested/hierarchical data; This includes effectively using R, SAS or other software for these data analyses

STAT 351 Nonparametric Statistical Methods (3 Credit Hours)
Pre-requisites: STAT 203 or STAT 335 with C- or better
This course will cover the basic principles of nonparametric methods in statistics including: one, two and K sample location methods; tests of randomness; tests of goodness of fit; nonlinear correlation; histogram; density estimation; nonparametric regression. Students should learn how to apply the nonparametric techniques in real datasets, interpret the results and draw conclusions.

STAT 370 Data Science Consulting (3 Credit Hours)
Pre-requisites: STAT 308
Students will work on a research project with a client acting as a consultant on the statistical and computational aspects of the project. Students are required to meet with a client, develop a strategy for addressing their problem, and present their results to the client (and their classmates).
This course satisfies the Engaged Learning requirement.
Outcomes:
1) Apply methods learned in classes to a address a real world problem; 2) Oral and Written presentation skills; 3) Collaboration skills

STAT 388 Topics (1-3 Credit Hours)
Pre-requisites: STAT 203 or STAT 335
This course covers advanced topics in statistics, such as multivariate analysis, sampling theory, non-parametric methods, decision theory, and Bayesian analysis.
Outcomes:
Students will obtain an understanding of an advanced topic in their major

STAT 390 Undergraduate Seminar (1 Credit Hour)
Pre-requisites: Senior Standing, including completion of MATH 304/ STAT 304
The seminar will cultivate students' presentation skills through participation in and critical discussion of brief lectures on familiar and unfamiliar topics; preparation and presentation of two brief lectures by the student (one on a familiar topic from the curriculum, one on a higher level material not customarily from the curriculum); and preparation of an extended abstract summarizing the advanced material presented.
Outcomes:
Students will gain the ability to present material in Statistics, and their applications to a general audience

STAT 391 Internship in Actuarial Science (1-3 Credit Hours)
Pre-requisites: STAT 304 and 396; approval of the internship director
This course offers an opportunity to obtain experience in actuarial science in a professional environment; placement requires approval of the internship coordinator and acceptance by an employer.
This course satisfies the Engaged Learning requirement.
Outcomes:
Students will obtain first hand experience doing actuarial work in a real world environment

STAT 396 Actuarial Seminar I (1 Credit Hour)
Pre-requisites: MATH 263
The seminar provides a comprehensive review of the probability topics that most commonly appear on the Actuarial Exam P. Topics covered include: axiomatic probability, combinatorial probability, conditional probability and Bayes' Theorem, independence, random variables and their various distributions, joint distributions, marginal distributions, conditional distributions of tow of more random variables.
Outcomes:
The purpose of the seminar is to prepare students for the Actuarial Exam P; The students will also learn test-taking strategies and will have the opportunity to take practice tests

STAT 397 Actuarial Seminar II (1 Credit Hour)
Pre-requisites: MATH 263
The seminar is a continuation of STAT 396. It provides a comprehensive review of topics in probability and risk management directed toward students preparing for the Actuarial Exam P. Additional topics may include order statistics, moment-generating functions, the Central Limit Theorem and risk analysis.
Outcomes:
The purpose of the seminar is to prepare students for the Actuarial Exam P; The students will also learn test-taking strategies and will have the opportunity to take practice tests

STAT 398 Independent Study (1-6 Credit Hours)
This course allows students to engage in independent study on selected topics in statistics under the supervision of a faculty member.
Outcomes:
Students will obtain an understanding of an advanced topic in their major

STAT 399H Honors Tutorial (1-3 Credit Hours)
This course allows students in the honors program to engage in independent study of selected topics in statistics for honors credit under the supervision of a faculty member.
Course equivalencies: STAT399H / STAT399
Outcomes:
Students will obtain an understanding of an advanced topic in their major