MATHEMATICAL SCIENCES

Department Chair: Ernest Rothman, Ph.D.

The Mathematical Sciences Department houses the disciplines of computer science, data science and analytics, mathematics, and statistics. Mathematics has always been the language of technology and the natural sciences; however, during the past several decades the influence of mathematics has spread to the life, management and social sciences as well. Furthermore, certain concepts inherent to mathematics, for example, respect for cause and effect, logic, honesty in presentation of material and critical thinking, are also at the heart of Western science and have been critical to the development of Western philosophy. Mathematics continues to be one of the greatest cultural and intellectual achievements of humankind. We wish to provide our students with the opportunity to develop an understanding and appreciation of this ongoing achievement. The mathematics programs at Salve Regina University support a liberal arts education by providing students a course of study to acquaint them with a broad range of concepts and tools of modern mathematics. These programs are designed for students to develop an appreciation for the beauty of mathematics and its power in applications, strengthen their powers of abstract reasoning, and develop their analytic ability for examining and discovering structures and patterns. The department offers programs leading to a major or minor in mathematics, an interdisciplinary minor in mathematical finance, and an interdisciplinary minor in data analytics. In addition to the major and minors, the department also offers courses to complete the core curriculum requirement in mathematics and provides courses that constitute mathematics, statistics, and computer science components of other programs at the University.

Along with degree programs taken entirely at Salve Regina University, the Mathematical Sciences Department at Salve Regina University offers the following dual degree programs with other universities: A 3+2 dual degree program leading to a B.A. in mathematics with a minor in data analytics from Salve Regina University and an M.S. in data science from the University of Massachusetts Dartmouth, and a 3+2 dual degree program leading to a B.A. in mathematics from Salve Regina University and a B.S. in electrical, mechanical, or systems engineering from Washington University in St. Louis. The department also offers a 3+3 dual degree program with Washington University St. Louis that leads to a B.A. in mathematics from Salve Regina University and a master's degree in engineering from Washington University in St. Louis.

Mathematical Sciences Student Learning Outcomes

At the completion of the program, students will be able to:

1. Demonstrate depth of knowledge in calculus, linear algebra, differential equations, and computer programming.
2. Apply content knowledge to solve complex mathematical problems (e.g., generalization, abstraction, modeling, apply mathematics in new context).
3. Demonstrate the ability to construct rigorous logical arguments.
4. Communicate mathematics effectively.

Bachelor's

- Dual Degree Mathematics (B.A.) and Data Science (M.S.) (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/dual-degree-mathematics-ba-data-science-ms/)
- Mathematics (B.A.) (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/mathematics-ba/)
- Mathematics (B.A.) leading to Electrical, Mechanical, or Systems Science and Engineering (B.S.) (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/mathematics-ba-electrical-mechanical-systems-science-engineering-bs/)
- Mathematics and Secondary Education (B.A.S.) (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/mathematics-secondary-education-bas/)

Minors

- Data Analytics Minor (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/data-analytics-minor/)
- Mathematical Finance Minor (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/mathematical-finance-minor/)
- Mathematics Minor (https://catalog.salve.edu/undergraduate/academic-programs/mathematical-sciences/mathematics-minor/)

Computer Science

CSC-103: Computer Programming I (3 Credits)
In this course students learn computer programming in a high-level object-oriented programming language. Topics include input/output, assignment, computation, data types, branching and selection, repetition, functions, recursion, exception handling, array-like structures, object-oriented design, algorithmic complexity, algorithms and data structures, and plotting.

CSC-104: Computer Programming II (3 Credits)
Pre-requisite(s): CSC-103 or equivalent is required.
Topics are selected from graph optimization problems, dynamical programming, random walks and data visualization, programs involving probability distributions, Monte Carlo simulation, sampling and confidence intervals, experimental data, randomized trials and other statistical programming, machine learning, clustering, and classification methods.

CSC-300: Algorithms and Data Structures (3 Credits)
Pre-requisite(s): CSC-104 or equivalent is required.
In this course, students study design and analysis of algorithms. Topics include asymptotic analysis; searching, sorting, heaps, hashing; divide-and-conquer; dynamic programming; greedy algorithms; graph algorithms; shortest path; network flow; dynamic data structures; parallel algorithms; and functional paradigm. This course can be used as an elective in the Data Analytics minor.

Data Science Analytics

DSA-201: Introduction to Data Science and Analytics (3 Credits)
In this course students are introduced to the fundamental concepts and tools of data science and analytics. Topics include the "data science life-cycle," programming environment such as R or Python, data collection and sampling in real-world problems, unstructured data, brief review of descriptive statistics and statistical plots, data transformations and missing data, visualization of multivariate data, clustering, univariate and multivariate regression, confirmatory data analysis.

DSA-202: Data Analysis and Visualization (3 Credits)
Pre-requisite(s): DSA-201 and CSC-103 are required., STA-173 or a MTH course numbered 172 or higher are required.
In this course students study data structures, data representation, data cleaning, visualization techniques, software for visualization and analysis, data patterns, time-dependent data, hypothesis generation, and descriptive statistics. Use of software such as Python along with selected data-science-related Python libraries and Tableau.

Mathematics

MTH-170: Concepts in Mathematics (3 Credits)
This course stresses the breadth of mathematics continuous and discrete, probabilistic as well as deterministic, computational and conceptual while providing students with tools needed to investigate, explore and understand the thematic connections that exist between discipline-based courses. Students investigate appropriate mathematical subject matter drawn from areas such as graphs and networks, the concept of change, combinatorics and probability, modern algebra and number theory. In addition to considering mathematical concepts that are the foundations of these areas in mathematics, students investigate applications of mathematics.
Fulfills Core Requirement in Mathematics.

MTH-171: Mathematics in Social Sciences (3 Credits)
Students study some of the great achievements and concepts in the discipline of mathematics. This course stresses the breadth and application of mathematics in the context of the social sciences while providing students with tools needed to investigate, explore and understand the thematic connections that exist between discipline-based courses. Students employ appropriate mathematical concepts to investigate questions related to such issues as voting systems, apportionment of representation and fair division of resources. In addition to considering mathematical concepts that are the foundation of these areas, students investigate applications of this mathematics.
Fulfills Core Requirement in Mathematics.

MTH-172: Quantitative Methods for Business (3 Credits)
Students study some of the great achievements and concepts in the discipline of mathematics along with their use in the analysis and solution of business problems. Students study the mathematics of finance, decision analysis, project management, and demand forecasting. Students study and apply the mathematical concepts related to expected value decision making and linear programming. Students also study exponential, trend adjusted, and seasonal forecasting as well as quantitative financial concepts such as interest, discounts, annuities, and present value analysis.
Fulfills Core Requirement in Mathematics.

MTH-173: Discrete Mathematics (3 Credits)
This is a course in the foundations of mathematical ideas that underlie the science of computing. The topics that are explored are logical operations, relations and arguments, mathematical induction and recursion, set relations and operations, combinatorics, elementary graph theory, algorithms and computation, and number theory with applications to cryptography.
Fulfills Core Requirement in Mathematics.

MTH-191: Applied Calculus (3 Credits)
Students study topics that include functions, models, and average rate of change, limits, instantaneous rates of change, the derivative, differentiation techniques, applications of the derivative, and a brief introduction to integration. High school algebra II is required.
Fulfills Core Requirement in Mathematics.

MTH-195: Calculus I (4 Credits)
This course covers the following topics: limits and continuity, the derivative, finding and interpreting the derivative, graphing and optimization, integrals of a function of one variable, the fundamental theorem of calculus, integration by parts. The level and pace of this course are generally greater than those of the Applied Calculus course (MTH-191), and some proofs of important theorems are studied. High school precalculus or equivalent is required.
Fulfills Core Requirement in Mathematics.

MTH-196: Calculus II (4 Credits)
Pre-requisite(s): MTH-195 or equivalent, or MTH-191 with consent of instructor is required.
This course covers the following topics: techniques and applications of integration, infinite series, parametric equations and polar coordinates, vectors and the geometry of space, functions of several variables, and partial derivatives. Some proofs of important theorems are studied.
Fulfills Core Requirement in Mathematics.

MTH-203: Calculus III (4 Credits)
Pre-requisite(s): MTH-196 or equivalent is required.
This course covers the following topics: applications of partial derivatives, multiple integrals, vector fields, divergence and curl of a vector field, line and surface integrals, Green's Theorem, Divergence Theorem and Stokes' Theorem and their applications. Some proofs of important theorems are studied.
Fulfills Core Requirement in Mathematics.

MTH-211: Linear Algebra (3 Credits)
Pre-requisite(s): MTH-196 or equivalent is required.
This course covers the following topics: matrix algebra, systems of linear equations, vector spaces, linear transformations, eigenvalues, eigenvectors and applications. Historical notes are included throughout the course.
Fulfills Core Requirement in Mathematics.

MTH-213: Differential Equations (3 Credits)
Pre-requisite(s): MTH-196 or equivalent, and MTH-211 or consent of instructor is required.
This course covers the following topics: first-order ordinary differential equations, higher-order linear differential equations, stability and phase plane analysis, Laplace transformations, series solutions, numerical methods, and applications. Historical notes are included throughout the course.

MTH-315: Geometry (3 Credits)
Pre-requisite(s): MTH-196 or consent of instructor is required.
Students study concepts of geometry. In particular, students study Euclidean and non-Euclidean geometries. Historical notes are included throughout the course.

MTH-399: Special Topics (1-3 Credits)
The purpose of this course is to provide an opportunity for students to investigate topics not covered in ordinary course work. The subject matter varies to suit the students and the interests of the professor.

MTH-411: Analysis I (3 Credits)
Pre-requisite(s): MTH-173 and MTH-203 are required.
Topics are chosen from functions of one and several variables, differentiation and Riemann integration, and sequences and series of numbers. Historical notes are included throughout the course.

MTH-412: Analysis II (3 Credits)
Pre-requisite(s): MTH-411 is required.
Topics are chosen from metric and normed spaces, sequences and series of functions, and complex variables. Historical notes are included throughout the course.

MTH-421: Abstract Algebra (3 Credits)
Pre-requisite(s): MTH-173 and MTH-211 are required.
In this course students study groups, rings and fields. Topics in number theory are also explored and historical notes are included throughout the course.

MTH-490: Senior Seminar Capstone (3 Credits)
This course serves as an integrative capstone for the major and the core. Students participate in a weekly seminar on topics in mathematics that build upon and extend beyond the material covered in our regular courses. Each student develops a proposal for an in-depth study of a particular topic of interest. Students will give a presentation of their topic in the seminar during the final weeks of the semester and a final written report will be submitted to the department faculty. This seminar serves as an integrative capstone linking enduring questions and interdisciplinary knowledge from the Core Curriculum to students' majors.

MTH-491: Internship (1-3 Credits)
Experiential course that provides students with practical work experience while acquiring or applying knowledge in one or more areas of mathematical sciences.

MTH-499: Independent Study (1-3 Credits)
Supervised study of a particular area of mathematical sciences not available in a regularly scheduled course.

Statistics

STA-173: Statistical Methods (3 Credits)
This course will address a broad spectrum of fundamental statistics concepts. The topics include exploratory data analysis, basic probability distributions, sampling distributions, interval estimations, hypothesis testing, and significance testing (P-Values) with single, paired and two-sample problems.

STA-341: Statistical Theory I (3 Credits)
Pre/Co-requisite(s): MTH-203 is required.
This course provides a calculus-based treatment of probability, which forms the foundation of statistics. Students study probability theory, combinatorics, random variables, discrete and continuous distribution theory, expected values, moment-generating functions, multivariate distributions, functions of random variables, and conditional and marginal probability distributions, and the Central Limit Theorem.

STA-342: Statistical Theory II (3 Credits)
Pre-requisite(s): STA-341 is required.
This course builds on the calculus-based treatment of probability provided in STA-341 to introduce concepts in statistics. Students study Chebyshev's Inequality and convergence in probability, descriptive statistics, exploratory data analysis, order statistics, least-squares regression; estimation including maximum likelihood, method of moments, unbiased, consistent, minimum variance estimators; confidence intervals, tests of hypotheses, significance testing with p-values, and goodness-of-fit tests. Other topics, as time permits.