Mathematics and Computer Science

Websites: Mathematics (https://new.sewanee.edu/programs-of-study/mathematics/), Computer Science (https://new.sewanee.edu/programs-of-study/computer-science/)

Mathematics

The study of mathematics at Sewanee is part of the formation of informed and discerning citizens, capable of critically analyzing information, weighing alternatives, and presenting reasoned arguments in order to navigate a rapidly changing world. While crucial for students who pursue concentrated study in mathematics or computer science, the exposure to abstraction and concise reasoning is also invaluable to students in fields as far-ranging as law, science, economics, and theology.

Computer Science

The world has come to depend on a rapid rate of technological evolution, and computer science majors are in great demand. This program instills a deep understanding of the science, mathematics, art, and social forces behind computer science, with electives as diverse as Principles of Interactive Computer Graphics (CSCI 360), Artificial Intelligence (CSCI 356), Functional Programming (CSCI 326), and Programming Languages (CSCI 376).

Data Science

Data science enjoys a rich history and its importance as a field of inquiry continues to grow. With the prevalence of data in the media, journals, news outlets and the Internet, an informed citizen needs the ability to distinguish between justified claims and those that are false or unsupported. A data-rich world also presents significant and unprecedented opportunities for addressing social and environmental issues in strategic ways. Those problems require researchers who are skilled data scientists, well-rounded scholars and nuanced thinkers.

A data science graduate will not only have the ability to critically analyze arguments which may use (or abuse) statistics and data, but will also learn the skills to guide a socially-impactful project from beginning to end: from idea development, to posing the pertinent questions, organizing the data gathering, analyzing the data and creating a report and presentation that uses compelling visualization and convincing arguments.

Faculty

Professor: Puckette

Associate Professors: Carl, Cavagnaro (Chair), Drinen, Duffee, Rudd, Sowell

Assistant Professors: Liu, Tu

Instructor: Quinn-Stine

Majors

Majors

- Mathematics (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/mathematics-major/)
- Computer Science (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/computer-science-major/)
- Data Science (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/data-science-major-applied-track/)

Minors

Minors

- Mathematics (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/mathematics-minor/)
- Computer Science (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/computer-science-minor/)
- Data Science (http://e-catalog.sewanee.edu/arts-sciences/departments-interdisciplinary-programs/mathematics-computer-science/data-science-minor/)

Courses

Computer Science Courses

CSCI 101   Introduction to Computer Science (4)
An introductory survey of computer science designed for liberal arts students, including such topics as machine architecture, language translation, artificial intelligence, and noncomputability.

CSCI 157   Introduction to Modeling and Programming (4)
An introduction to creative modeling of both natural and virtual worlds, in which students gain understanding of human interaction with computing devices as well as the expertise needed for further course work in computer science. Lab experiences using the explicit notation of a programming language reinforce the application of abstractions while affording practice in algorithmic problem solving and relevant theory.

CSCI 257   Object-Oriented Programming (4)
Software design and development using object-oriented programming techniques. Topics include abstract data types and their implementation using classes, design methodologies, recursion, elementary data structures, and implementation of larger programs. *Prerequisite: CSCI 157.*

CSCI 270   Computer Systems and Organization (4)
This course explores levels of abstraction in computer systems, processors and related hardware components, instruction sets, program execution, and process management. *Prerequisite: CSCI 157.*

CSCI 276   Multimedia Programming and Design (4)
An introduction to object-oriented programming techniques that underlie the creation, manipulation, and transmission of digital media, including digital photography, audio, and video. Topics include scaling and transforming pictures, sound waveform visualization and manipulation, MIDI, chromakey, frame-based animation, and compression, encoding, and transmission of digital media over the Internet. *Prerequisite: CSCI 157.*

CSCI 277   Modeling Physical Systems (4)
This course introduces the tools and techniques used to model natural systems in software. Techniques studied are important not only in scientific programs, but also in graphics, game engines, and animation; these include vectors, particle systems, fractals, and autonomous agents. Students will apply these to abstractions of physical systems such as predator-prey models, flocking, cellular automata, genetic algorithms, and artificial neural networks. *Prerequisite: CSCI 157.*

CSCI 284   Database Design with Web Applications (4)
This course provides students with a working knowledge of the power and potential of modern networked databases as well as of common uses and abuses. Students receive hands-on experience with open source development tools, which are widely used for building and placing databases on the web. Database development is explored, from conceptual elaboration through design and implementation, and interview techniques for effective database design are considered. Programming techniques are introduced for building, maintaining, accessing, interacting, and protecting the information in large data depositories. Discussions include consideration of concerns driving policy decisions for amassing and managing sensitive, and sometimes dangerous, information collections. *Prerequisite: CSCI 157.*

CSCI 286   Computer Mapping and Geolocation (4)
An introduction to computer location algorithms and networks with an emphasis on fundamental principles, this course provides basic understanding of location services and underlying technologies, including comparisons of popular mapping and geolocation programming technologies appropriate for web and mobile platforms. *Prerequisite: CSCI 257.*

CSCI 290   Data Mining (4)
Data mining is the automated analysis of large quantities of data to extract previously unknown patterns such as clusters, anomalies, relationships, and dependencies. As large columns of data accumulate, techniques are needed to make sense of the stored information and predict future trends. Data mining applications have become important in fields such as finance, healthcare, manufacturing, and marketing. This course introduces students to the principal ideas in statistical learning, including areas such as classification, clustering, and data extraction. Along the way, students develop problem-solving skills and an understanding of programming techniques and data structures. *Prerequisite: CSCI 257 or CSCI 284.*

CSCI 320   Data Structures and Algorithms (4)
The design, implementation, and application of data structures and their algorithms, including stacks, queues, linked structures, trees and graphs. Other topics include elementary searching and sorting algorithms, pattern matching, and runtime performance analysis. *Prerequisite: CSCI 257 and MATH 215.*

CSCI 326   Functional Programming (4)
Data abstraction and data-driven recursion, higher-order functions, and the management of state. An exploration of the functional paradigm in the context of concurrent and distributed computing. *Prerequisite: CSCI 257.*

CSCI 336   Algorithmic Design and Analysis (4)
Systematic study of the correctness and complexity of algorithms, including design strategies, proof techniques, asymptotic bounds and recurrence relations for analyzing recursive algorithms. NP-complete and intractable problems. Case studies based on searching, sorting, numeric and graph algorithms; advanced tree and graph structures, and symbol tables. *Prerequisite: CSCI 320 and MATH 215.*

CSCI 352   Human-Robot Interaction (4)
This course focuses on the emerging field of human-robot interaction, bringing together research and application of methodology from robotics, human factors, human-computer interaction, interaction design, cognitive psychology, education, and other fields to enable robots to have more natural and more rewarding interactions with humans throughout their spheres of functioning. This course is a combination of state-of-art reading and discussions, focused exercises and problem-solving sessions in human-robot interaction, and a group project that includes the design, development, and evaluation of a human-robot interaction system. *Prerequisite: CSCI 257.*

CSCI 356   Artificial Intelligence (4)
Knowledge representation, expert systems, natural language processing, computer vision, machine learning, game playing, cognition. *Prerequisite: CSCI 257 and MATH 215.*

CSCI 360   Principles of Interactive Computer Graphics (4)
Introduction to interactive computer graphics including 2D and 3D viewing, clipping, hidden line/surface removal, shading, interaction handling, geometrical transformations, projections, and hierarchical data structures. Brief introductions to related and dependent fields of physically-based modeling and scientific visualization will be included. *Prerequisite: CSCI 257 and MATH 215.*

CSCI 370   Computer Architecture (4)
Advanced processor design including pipelining, speculative execution, hyperthreading and their effects on program execution. The memory hierarchy and virtual memory design. *Prerequisite: CSCI 257 and CSCI 270.*

CSCI 376   Programming Languages (4)
Imperative, object-oriented, declarative, and functional programming language paradigms. *Prerequisite: CSCI 257 and MATH 215.*

CSCI 415   Special Topics (2 or 4)
This course explores emerging concepts, methodologies, and applications to other disciplines in the field of computer science. This course may be repeated for credit when the topic differs. *Prerequisite: CSCI 257.*

CSCI 428   Operating Systems (4)
Process management, memory management, processor scheduling, file systems, concurrent programming, distributed processing, security. *Prerequisite: (CSCI 270 or CSCI 370) and MATH 215.*

CSCI 444   Independent Study (2 or 4)
An opportunity for advanced students to pursue topics of special interest. *Prerequisite: Instructor prerequisite override required.*

Mathematics Courses

MATH 100   Topics in Mathematics (4)
Intended for prospective majors outside of mathematics, computer science, and the physical sciences, this course focuses on one or more important areas of mathematics with emphasis on the creativity and power of abstract representation, mathematical inquiry, and logical reasoning. Specific past topics have included calculus, probability, number theory, group theory, and encryption. Current topics vary by instructor.

MATH 101   Calculus I (4)
An elementary course introducing the student to the basic concepts of calculus: functions, transcendental functions, limits, derivatives, and integrals. Emphasis on problem solving. *Prerequisite: Placement.*

MATH 102   Calculus II (4)
A continuation of Calculus I. Topics include further theory and applications of integration, techniques of integration, and introduction to series. Some work with a computer is included. *Prerequisite: MATH 101 or placement.*

MATH 207   Multidimensional Calculus (4)
Calculus of several variables. Vectors, partial and directional derivatives, space curves, gradients, maxima and minima, linear and differentiable transformations, vector fields, line integrals, multidimensional Riemann integrals, and applications in physics and geometry are considered. *Prerequisite: MATH 102 or placement.*

MATH 210   Linear Algebra (4)
A course designed to provide some important mathematical tools useful in a variety of fields. Systems of linear equations, vectors and matrices, determinants, vector spaces, linear transformations, inner and cross products, and eigen values and canonical forms are considered. *Prerequisite: One course with attribute G5Q..*

MATH 212   Differential Equations (4)
Ordinary differential equations, with applications. Methods of numerical approximation, power series, and Laplace transforms. Existence and uniqueness of solution. *Prerequisite: One course with attribute G5Q..*

MATH 215   Discrete Mathematical Structures (4)
This course is required for most courses in mathematics or computer science numbered 300 or above. Topics normally include the following: logic, sets, functions, relations, graphs and trees, mathematical induction, combinatorics, recursion, and algebraic structures. The subject matter is to be of current interest to both mathematics and computer science students. *Prerequisite: One course with attribute G5Q..*

MATH 303   Analysis I (4)
A rigorous treatment of continuity, differentiation, and integration for functions of a real variable. The course also includes convergence of series and sequences of functions as well as topology of the real line. *Prerequisite: MATH 207 and MATH 215.*

MATH 305   Abstract Algebra I (4)
A study of these important algebraic structures: integral domains, polynomials, groups, vector spaces, rings and ideals, fields, and elementary Galois theory. *Prerequisite: MATH 215.*

MATH 306   Abstract Algebra II (4)
A study of these important algebraic structures: integral domains, polynomials, groups, vector spaces, rings and ideals, fields, and elementary Galois theory. *Prerequisite: MATH 305.*

MATH 311   Functions of a Complex Variable (4)
An introduction to analytic functions. Rational, exponential, logarithmic, and trigonometric functions in the complex plane, Cauchy's integral formula, Taylor series, Laurent series, residues, poles, and conformal mapping are considered along with applications to physical problems and other areas of mathematics. *Prerequisite: MATH 207 and MATH 215.*

MATH 313   Algebraic Number Theory (4)
Largely an algebraic study of the standard number-theoretic functions, congruences, primes, quadratic residues, and other topics selected according to the interests of the students and instructor. *Prerequisite: MATH 215.*

MATH 314   Topology (4)
An introduction to point-set topology with emphasis on Euclidean spaces and applications to analysis. Topics include connectedness, compactness, countability conditions, separation properties, metric spaces, continuity, homeomorphisms, and product spaces. *Prerequisite: MATH 215.*

MATH 321   Probability and Statistics I (4)
A treatment of probability and a logical development of the framework of mathematical statistics. Topics include random variables, distribution functions, sampling, and statistical inference. *Prerequisite: MATH 207.*

MATH 322   Probability and Statistics II (4)
A treatment of probability and a logical development of the framework of mathematical statistics. Topics include random variables, distribution functions, sampling, and statistical inference. *Prerequisite: MATH 321.*

MATH 330   History of Mathematics (4)
A survey of classical mathematics from ancient times to the development of calculus, together with selected topics from the history of modern mathematics. *Prerequisite: MATH 102.*

MATH 332   Mathematical Modeling (4)
An introduction to the creation of mathematical models, both deterministic and probabilistic, for the description of problems drawn from physical, biological, social, and environmental sources. *Prerequisite: MATH 215 and CSCI 157.*

MATH 334   Partial Differential Equations and Modeling (4)
This course addresses the techniques and theory of partial differential equations. Many physical and biological applications and models are explored, including the heat equation, the wave equation, and LaPlace's equation. Significant attention is given to both theory and applications. *Prerequisite: MATH 207 and MATH 212.*

MATH 401   Analysis II (4)
A concentrated study of the theory of functions of a real variable. Abstract methods are emphasized. Students are active participants in the presentation. *Prerequisite: MATH 303.*

MATH 402   Special Topics (4)
Study of a variable topic in mathematics. This course may be repeated for credit when the topic differs. *Prerequisite: MATH 215.*

MATH 416   Algebraic Topology (4)
An introduction to algebraic and combinational topology with emphasis on applications to analysis and Euclidean geometry. Topics covered include simplicial homology, the fundamental group, covering spaces, the higher homotopy groups, and the homology sequence. *Prerequisite: MATH 314.*

MATH 444   Independent Study (2 or 4)
An opportunity for advanced students to pursue topics of special interest. *Prerequisite: Instructor prerequisite override required.*

Statistics Courses

STAT 100   Data Science and Citizenship (4)
This course explores the complex ways in which we interact with data in everyday life. While thinking critically about the role of data science in advancing social good, students will gain fundamental skills in data literacy and open-source programming tools for data science.

STAT 204   Elementary Statistics (4)
An introduction to statistics covering these topics: probability, binomial and normal distributions, mean, median, variance, standard deviation, the distinction between sample and population, t-distribution, hypothesis testing, confidence intervals, and linear regression.

STAT 214   Statistical Modeling (4)
This course focuses on choosing, fitting, assessing, and using statistical models. Topics include simple and multiple linear regression, logistic regression, and multifactor analysis of variance. Intended for students in the physical, natural or social sciences. *Prerequisite: (STAT 204 or MATH 322) and CSCI 157.*

STAT 302   Bayesian Statistics (4)
An introduction to the Bayesian approach to statistical inference. Topics include: basic probability theory, Bayes Theorem, prior distributions and conjugate priors, Markov Chain Monte Carlo methods, applications of Bayesian statistics (e.g. Bayesian networks, decision trees). *Prerequisite: STAT 204 or MATH 321.*

STAT 304   Experimental Design and Analysis (4)
This course covers the selection of an appropriate experimental design (e.g., factorial crossing, complete block, Latin square), determination of sample size, issues with multiple comparisons, and assessment of the assumptions of statistical models. *Prerequisite: STAT 204 or MATH 322.*

STAT 306   Time Series (4)
An introduction to time series and forecasting methods with applications in economics, engineering and the natural and social sciences. *Prerequisite: MATH 210 and (STAT 204 or MATH 322).*

STAT 336   Sports Analytics (4)
We make use of publicly available sports data sets to analyze, predict, and rank team and player performance, and analyze strategic decisions arising in various sports. *Prerequisite: (STAT 204 or MATH 322) and CSCI 157.*

STAT 410   Data Science Practicum (4)
Each student will participate on a team that will complete a project from the initial scoping phase through data collection, analysis, and culminate in a deliverable product in the form of both a written report and public presentation. *Open only to seniors.*

STAT 444   Independent Study (2 or 4)
An opportunity for advanced students to pursue topics of special interest. *Prerequisite: Instructor prerequisite override required.*