APPLIED MATHEMATICS (AMTH)

**AMTH 160b / MATH 160b / S&DS 160b, The Structure of Networks**  Staff
Network structures and network dynamics described through examples and applications ranging from marketing to epidemics and the world climate. Study of social and biological networks as well as networks in the humanities. Mathematical graphs provide a simple common language to describe the variety of networks and their properties.  QR

**AMTH 222a or b / MATH 222a or b, Linear Algebra with Applications**  Staff

**AMTH 244a or b / MATH 244a or b, Discrete Mathematics**  Staff
Basic concepts and results in discrete mathematics: graphs, trees, connectivity, Ramsey theorem, enumeration, binomial coefficients, Stirling numbers. Properties of finite set systems. Recommended preparation: MATH 115 or equivalent.  QR

**AMTH 247b / MATH 247b, Intro to Partial Differential Equations**  Erik Hiltunen
Introduction to partial differential equations, wave equation, Laplace’s equation, heat equation, method of characteristics, calculus of variations, series and transform methods, and numerical methods. Prerequisites: MATH 222 or 225 or 226, MATH 246 or ENAS 194 or equivalents.  QR

**AMTH 262a / CPSC 262a / S&DS 262a, Computational Tools for Data Science**  Roy Lederman
Introduction to the core ideas and principles that arise in modern data analysis, bridging statistics and computer science and providing students the tools to grow and adapt as methods and techniques change. Topics include principal component analysis, independent component analysis, dictionary learning, neural networks and optimization, as well as scalable computing for large datasets. Assignments include implementation, data analysis and theory. Students require background in linear algebra, multivariable calculus, probability and programming. Prerequisites: after or concurrently with MATH 222, 225 or 226; after or concurrently with MATH 120, 235, or ENAS 151; after or concurrently with CPSC 100, 112, or ENAS 130; after S&DS 100-108 or S&DS 230 or S&DS 241 or S&DS 242. Enrollment is limited; requires permission of the instructor.  QR

* **AMTH 342a / EENG 432a, Linear Systems**  A Stephen Morse
Introduction to finite-dimensional, continuous, and discrete-time linear dynamical systems. Exploration of the basic properties and mathematical structure of the linear systems used for modeling dynamical processes in robotics, signal and image processing, economics, statistics, environmental and biomedical engineering, and control theory. Prerequisite: MATH 222 or permission of instructor.  QR

**AMTH 361b / S&DS 361b, Data Analysis**  Elena Khusainova
Selected topics in statistics explored through analysis of data sets using the R statistical computing language. Topics include linear and nonlinear models, maximum likelihood, resampling methods, curve estimation, model selection, classification, and clustering. After S&DS 242 and MATH 222 or 225, or equivalents.  QR

* **AMTH 362a / CPSC 362a / EENG 435b, Decisions and Computations across Networks**  A Stephen Morse
For a long time there has been interest in distributed computation and decision making problems of all types. Among these are consensus and flocking problems, the multi-agent rendezvous problem, distributed averaging, gossiping, localization of sensors in a multi-sensor network, distributed algorithms for solving linear equations, distributed management of multi-agent formations, opinion dynamics, and distributed state estimation. The aim of this course is to explain what these problems are and to discuss their solutions. Related concepts from spectral graph theory, rigid graph theory, non-homogeneous Markov chain theory, stability theory, and linear system theory are covered. Although most of the mathematics need is covered in the lectures, students taking this course should have a working understanding of basic linear algebra. The course is open to all students. Prerequisite: Linear algebra or instructor permission.  SC

**AMTH 364b / EENG 454b / S&DS 364b, Information Theory**  Andrew Barron
Foundations of information theory in communications, statistical inference, statistical mechanics, probability, and algorithmic complexity. Quantities of information and their properties: entropy, conditional entropy, divergence, redundancy, mutual information, channel capacity. Basic theorems of data compression, data summarization, and channel coding. Applications in statistics and finance. After STAT 241.  QR

**AMTH 420b / MATH 421b, The Mathematics of Data Science**  Anna Gilbert
This course aims to be an introduction to the mathematical background that underlies modern data science. The emphasis is on the mathematics but occasional applications are discussed (in particular, no programming skills are required). Covered material may include (but is not limited to) a rigorous treatment of tail bounds in probability, concentration inequalities, the Johnson-Lindenstrauss Lemma as well as fundamentals of random matrices, and spectral graph theory. Prerequisite: MATH 305.  QR, SC

**AMTH 428a / E&EB 428a / EPS 428a / PHYS 428a, Science of Complex Systems**  Jun Korenaga
Introduction to the quantitative analysis of systems with many degrees of freedom. Fundamental components in the science of complex systems, including how to simulate complex systems, how to analyze model behaviors, and how to validate models using observations.
Topics include cellular automata, bifurcation theory, deterministic chaos, self-organized criticality, renormalization, and inverse theory. Prerequisite: PHYS 301, MATH 247, or equivalent. QR, SC

**AMTH 431a / S&DS 431a, Optimization and Computation** Anna Gilbert
This course is designed for students in Statistics & Data Science who need to know about optimization and the essentials of numerical algorithm design and analysis. It is an introduction to more advanced courses in optimization. The overarching goal of the course is to teach students how to design algorithms for Machine Learning and Data Analysis (in their own research). This course is not open to students who have taken S&DS 430. Prerequisites: Knowledge of linear algebra, multivariate calculus, and probability. Linear Algebra, by MATH 222, 223 or 230 or 231; Graph Theory, by MATH 244 or CPSC 365 or 366; and comfort with proof-based exposition and problem sets, such as is gained from MATH 230 and 231, or CPSC 366.

**AMTH 447a / MATH 447a, Partial Differential Equations** John Schotland
Introduction to partial differential equations, wave equation, Laplace's equation, heat equation, method of characteristics, calculus of variations, series and transform methods, and numerical methods. Prerequisites: MATH 305

* **AMTH 480a, Directed Reading** John Wettlaufer
Individual study for qualified students who wish to investigate an area of applied mathematics not covered in regular courses. A student must be sponsored by a faculty member who sets the requirements and meets regularly with the student. Requires a written plan of study approved by the faculty adviser and the director of undergraduate studies.

* **AMTH 482a, Research Project** John Wettlaufer
Individual research. Requires a faculty supervisor and the permission of the director of undergraduate studies. The student must submit a written report about the results of the project. May be taken more than once for credit.

* **AMTH 491a, Senior Project** John Wettlaufer
Individual research that fulfills the senior requirement. Requires a faculty supervisor and the permission of the director of undergraduate studies. The student must submit a written report about the results of the project.