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 260b / MATH 260b, Basic Analysis in Function Spaces  Ronald Coifman
Diagonalization of linear operators, with applications in physics and engineering; calculus of variations; data analysis. MATH 260 is a natural continuation of PHYS 301. Prerequisites: MATH 120, and 222 or 225 or 226.  QR

AMTH 262b / CPSC 262b / S&DS 262b, 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 231; after or concurrently with MATH 120, 230, 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 322a / MATH 322a, Geometric and Topological Methods in Machine Learning
Smita Krishnaswamy and Ian Adelstein
This course provides an introduction to geometric and topological methods in data science. Our starting point is the manifold hypothesis: that high dimensional data live on or near a much lower dimensional smooth manifold. We introduce tools to study the geometric and topological properties of this manifold in order to reveal relevant features and organization of the data. Topics include: metric space structures, curvature, geodesics, diffusion maps, eigenmaps, geometric model spaces, gradient descent, data embeddings and projections, and topological data analysis (TDA) in the form of persistence homology and their associated “barcodes.” We see applications of these methods in a variety of data types. Prerequisites: MATH 225 or 226; MATH 255 or 256; MATH 302; and CPSC 112 or equivalent programming experience. Students who completed MATH 231 or 250 may substitute another analysis course level 300 or above in place of MATH 302. QR, SC

* 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  Brian Macdonald
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 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 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  Yang Zhuoran
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 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 482a or b, 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 or b, 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.