ENGINEERING SCIENCES AND APPLIED MATHEMATICS

mccormick.northwestern.edu/applied-math

The Department of Engineering Sciences and Applied Mathematics offers coursework in applied mathematics and administers an undergraduate program leading to a BS in applied mathematics and a graduate program in applied mathematics.

The applied mathematics program is intended to provide the knowledge necessary for applying mathematical ideas and techniques to the problems that arise in engineering or science. It is expected that a student receiving a BS in applied mathematics would have the background for suitable employment in industry or for graduate study in either mathematics (pure or applied) or an engineering field, including computer science and operations research. To achieve these goals, the applied mathematics program is designed to be flexible and allow the student to concentrate a substantial part of the coursework either in mathematics or one or more areas of application.

Program of Study

- Applied Mathematics Degree (https://catalogs.northwestern.edu/undergraduate/engineering-applied-science/engineering-sciences-applied-mathematics/applied-mathematics-degree/)

ES_APPM 245-0 Elementary Applied Linear Algebra (1 Unit) Basic linear algebra methods including basic matrix/vector operations, solution of linear systems of equations, eigenvalues, and singular values. Focus will be on applications of the methods on a range of engineering topics including: least squares and data fitting, game theory, graph theory, principal component analysis, linear programming, and other related engineering topics.

ES_APPM 252-1 Honors Calculus for Engineers (1 Unit) Alternative to standard calculus sequence. Covers more material at a deeper level with more applications. Satisfies same requirements as MATH 228-1 and MATH 228-2. Prerequisite: invitation or consent of instructor.

ES_APPM 252-2 Honors Calculus for Engineers (1 Unit) Alternative to standard calculus sequence. Covers more material at a deeper level with more applications. Satisfies same requirements as MATH 228-1 and MATH 228-2. Prerequisite: invitation or consent of instructor.

ES_APPM 311-0 Methods of Applied Mathematics (1 Unit)
Ordinary differential equations: Sturm-Liouville theory, properties of special functions, solution methods including Laplace transforms, Fourier series, eigenvalue problems and expansions in orthogonal functions. Partial differential equations: classification, separation of variables, solution by series and transform methods.
Prerequisites: MATH 250-0, or GEN_ENG 205-4, or GEN_ENG 206-4.

ES_APPM 312-0 Complex Variables (1 Unit)
Imaginary numbers and complex variables, analytic functions, calculus of complex functions, contour integration with application to transform inversion, conformal mapping.
Prerequisite: GEN_ENG 205-4, GEN_ENG 206-4, or MATH 250-0.

ES_APPM 322-0 Applied Dynamical Systems (1 Unit)
Example-oriented survey of nonlinear dynamical systems, including chaos. Combines numerical exploration of differential equations describing physical problems with analytic methods and geometric concepts. Applications to mechanical, fluid dynamical, electrical, chemical, and biological systems.
Prerequisites: GEN_ENG 205-4, GEN_ENG 206-4, or MATH 250-0. ES_APPM 311-1 is recommended.

ES_APPM 344-0 High Performance Scientific Computing (1 Unit)
Solving partial differential equations using high performance computing platforms. Basic C programming. Distributed computing using MPI. GPU programming using CUDA. Adaptation of algorithms for solving PDE's to different architectures.

ES_APPM 345-0 Applied Linear Algebra (1 Unit)
Understanding and implentation of algorithms to calculate matrix decompositions such as eigenvalue/vector, LU, QR, and SVD decompositions. Applications include data-fitting, image analysis, and ranking algorithms.

ES_APPM 346-0 Modeling and Computation in Science & Engineering (1 Unit)
Advanced techniques for initial value problems, differential algebraic systems, bifurcations, chaos, and partial differential equations. Applications drawn from different physical areas.
Prerequisites: MATH 228-2, MATH 240-0, and MATH 250-0; or GEN_ENG 205-4 and PHYSICS 135-1, PHYSICS 135-2; or equivalent; familiarity with a programming language; or consent of instructor.

ES_APPM 370-1 Introduction to Computational Neuroscience (1 Unit)
From neurons to networks. Ion channels, Hodgkin-Huxley framework, simplified models, cable equation, synapses, spike triggered average, and optimal stimulus. Feedforward and recurrent firing rate networks. Statistical approach, Bayesian modeling. Brief introduction to numerical methods.

ES_APPM 375-1 Quantitative Biology I: Experiments, Data, Models, and Analysis (1 Unit)
High-resolution, high-throughput, and dynamic imaging and sequencing data is the substrate of modern biology. The course consists of case-studies where we learn how to computational work with, analyze, and make sense of experimental dataset using fundamental principles of mathematics, statistics, and physics. No formal course prerequisites. Programming in python.

ES_APPM 375-2 Quantitative Biology II: Experiments, Data, Models, and Analysis (1 Unit)
High-resolution, high-throughput, and dynamic imaging and sequencing data is the substrate of modern biology. In this course we learn how to perform experiments, and computational work with, analyze, and make sense of experimental dataset using fundamental principles of mathematics, statistics, and physics. No formal course prerequisites. Programming in python.

ES_APPM 395-0 Special Topics (1 Unit)

ES_APPM 398-0 Introduction to Applied Math Research (0 Unit)
This is a seminar course where ESAM faculty present their current and planned research topics in applied mathematics.

ES_APPM 399-0 Projects (1 Unit) Special studies to be carried out under faculty direction. Credit to be arranged.