# AMSC - APPLIED MATHEMATICS & SCIENTIFIC COMPUTATION

**AMSC420 Mathematical Modeling (3 Credits)**
The course will develop skills in data-driven mathematical modeling through individual and group projects. Emphasis will be placed on both analytical and computational methods, and on effective oral and written presentation of results.
**Prerequisite:** 1 course with a minimum grade of C- from (MATH240, MATH461, MATH341); and 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (MATH246, MATH341); and 1 course with a minimum grade of C- from (STAT400, STAT410); and 1 course with a minimum grade C- from (CMSC106, CMSC131).
**Recommended:** AMSC460 or AMSC466.
**Cross-listed with:** MATH420.
**Credit Only Granted for:** AMSC420 or MATH420.

**AMSC452 Introduction to Dynamics and Chaos (3 Credits)**
An introduction to mathematical dynamics and chaos. Orbits, bifurcations, Cantor sets and horseshoes, symbolic dynamics, fractal dimension, notions of stability, flows and chaos. Includes motivation and historical perspectives, as well as examples of fundamental maps studied in dynamics and applications of dynamics.
**Prerequisite:** MATH341; or MATH246 and one of (MATH240 or MATH461).
**Cross-listed with:** MATH452.
**Credit Only Granted for:** AMSC452 or MATH452.

**AMSC460 Computational Methods (3 Credits)**
Basic computational methods for interpolation, least squares, approximation, numerical quadrature, numerical solution of polynomial and transcendental equations, systems of linear equations and initial value problems for ordinary differential equations. Emphasis on methods and their computational properties rather than their analytic aspects. Intended primarily for students in the physical and engineering sciences.
**Prerequisite:** 1 course with a minimum grade of C- from (MATH240, MATH341, MATH461); and 1 course with a minimum grade of C- from (MATH241, MATH340); and 1 course with a minimum grade of C- from (CMSC106, CMSC131); and 1 course with a minimum grade of C- from (MATH246, MATH341).
**Cross-listed with:** CMSC460.
**Credit Only Granted for:** AMSC460, AMSC466, CMSC460, or CMSC466.

**AMSC466 Introduction to Numerical Analysis I (3 Credits)**
Floating point computations, direct methods for linear systems, interpolation, solution of nonlinear equations.
**Prerequisite:** 1 course with a minimum grade of C- from (CMSC106, CMSC131); and minimum grade of C- in MATH410.
**Cross-listed with:** CMSC466.
**Credit Only Granted for:** AMSC460, CMSC460, AMSC466, or CMSC466.

**AMSC498 Selected Topics in Applied Mathematics (1-3 Credits)**
Topics in applied mathematics of special interest to advanced undergraduate students.
**Repeatable to:** 6 credits if content differs.

**AMSC660 Scientific Computing I (3 Credits)**
Fundamental techniques in scientific computation with an introduction to theory and software for each topic. Computer numbers and sources of errors, numerical linear algebra, optimization, and Monte Carlo methods.
**Prerequisite:** Must have knowledge of Matlab or Python.
**Cross-listed with:** CMSC660.
**Credit Only Granted for:** AMSC660 or CMSC660.

**AMSC661 Scientific Computing II (3 Credits)**
Numerical methods for solving ordinary and partial differential equations (elliptic, parabolic, hyperbolic, and dispersive): motivation, analysis, and implementation. Finite difference methods, finite element methods, Fourier and Chebyshev spectral methods, and meshless methods.
**Prerequisite:** Must have knowledge of Matlab or Python. Must have basic knowledge of ordinary and partial differential equations (MATH246 and MATH462 or equivalent, or permission of instructor).
**Cross-listed with:** CMSC661.
**Credit Only Granted for:** AMSC661 or CMSC661.

**AMSC662 Computer Organization and Programming for Scientific Computing (3 Credits)**
This course presents fundamental issues of computer hardware, software parallel computing, and scientific data management for programming for scientific computation.
**Prerequisite:** Must have Knowledge of C or Fortran.
**Cross-listed with:** CMSC662.
**Credit Only Granted for:** AMSC662 or CMSC662.

**AMSC663 Advanced Scientific Computing I (3 Credits)**
In the sequence Advanced Scientific Computing I & Advanced Scientific Computing II, (CMSC663/CMSC663 and AMSC664/CMSC664, respectively) students work on a year-long individual project to develop software for a scientific task in a high performance computing environment. Lectures will be given on available computational environments, code development, implementation of parallel algorithms.
**Prerequisite:** AMSC660 or CMSC660; and (AMSC661 or CMSC661).
**Cross-listed with:** CMSC663.
**Restriction:** Permission of instructor.
**Credit Only Granted for:** AMSC663 or CMSC663.

**AMSC664 Advanced Scientific Computing II (3 Credits)**
In the sequence Advanced Scientific Computing I & Advanced Scientific Computing II, (AMSC663/CMSC663 and CMSC664/CMSC664, respectively) students work on a year-long individual project to develop software for a scientific task in a high performance computing environment. Lectures will be given on available computational environments, code development, implementation of parallel algorithms.
**Prerequisite:** AMSC663 or CMSC663.
**Cross-listed with:** CMSC664.
**Restriction:** Permission of instructor.
**Credit Only Granted for:** AMSC664 or CMSC664.

**AMSC666 Numerical Analysis I (3 Credits)**
Approximation theory, numerical solution of initial-value problems, iterative methods for linear systems, optimization.
**Prerequisite:** CMSC466 or AMSC466; and MATH410.
**Cross-listed with:** CMSC666.
**Credit Only Granted for:** AMSC666 or CMSC666.

**AMSC670 Ordinary Differential Equations I (3 Credits)**
Existence and uniqueness, linear systems usually with Floquet theory for periodic systems, linearization and stability, planar systems usually with Poincare-Bendixson theorem.
**Prerequisite:** MATH405.
**Cross-listed with:** MATH670.
**Credit Only Granted for:** AMSC670 or MATH670.

**AMSC671 Ordinary Differential Equations II (3 Credits)**
The content of this course varies with the interests of the instructor and the class. Stability theory, control, time delay systems, Hamiltonian systems, bifurcation theory, and boundary value problems.
**Prerequisite:** MATH630.
**Cross-listed with:** MATH671.
**Credit Only Granted for:** AMSC671 or MATH671.

**AMSC673 Partial Differential Equations I (3 Credits)**
Analysis of boundary value problems for Laplace's equation, initial value problems for the heat and wave equations. Fundamental solutions, maximum principles, energy methods. First order nonlinear PDE, conservation laws. Characteristics, shock formation, weak solutions. Distributions, Fourier transform.
**Prerequisite:** MATH411; or students who have taken courses with comparable content may contact the department.
**Cross-listed with:** MATH673.
**Credit Only Granted for:** AMSC673 or MATH673.

**AMSC674 Partial Differential Equations II (3 Credits)**
Boundary value problems for elliptic partial differential equations via operator-theoretic methods. Hilbert spaces of functions. Duality, weak convergence. Sobolev spaces. Spectral theory of compact operators. Eigenfunction expansions.
**Prerequisite:** MATH673 or AMSC673; or permission of instructor.
**Cross-listed with:** MATH674.
**Credit Only Granted for:** AMSC674 or MATH674.

**AMSC689 Research Interactions in Applied Mathematics and Scientific Computation (1-3 Credits)**
The students participate in a vertically integrated (undergraduate, graduate and/or postdoctoral, faculty) research group. Format varies, but includes regular meetings, readings and presentations of material. See graduate program's online syllabus or contact the graduate program director for more information.
**Restriction:** Permission of instructor.
**Repeatable to:** 6 credits if content differs.

**AMSC698 Advanced Topics in Applied Mathematics (1-4 Credits)**
**Repeatable to:** 99 credits if content differs.

**AMSC699 Applied Mathematics Seminar (1-3 Credits)**
Seminar to acquaint students with a variety of applications of mathematics and to develop skills in presentation techniques.
**Repeatable to:** 99 credits if content differs.

**AMSC714 Numerical Methods For Stationary PDEs (3 Credits)**
Topics include: Maximum principle, finite difference method, upwinding, error analysis; Variational formulation of elliptic problems, inf-sup theory; The finite element method and its implementation; Piecewise polynomial interpolation theory in Sobolev spaces; A priori and a posteriori error analyses, adaptivity; Fast solvers; Variational crimes; Mixed finite element methods.
**Prerequisite:** One graduate level course in partial differential equations or one graduate level course in numerical analysis or scientific computing; or permission of instructor.
**Credit Only Granted for:** AMSC 714 or AMSC 614.
**Formerly:** AMSC614.
**Additional Information:** This course is a complement to the graduate courses MATH 673 and MATH 674 in PDEs, AMSC 666 in numerical analysis, and AMSC 660 and AMSC 661 in scientific computing.

**AMSC715 Numerical Methods for Evolution Partial Differential Equations (3 Credits)**
Topics include: Heat and wave equations: maximum principle, energy methods and Sobolev spaces, finite difference and finite element methods, von Neumann analysis, stability and error estimates;Linear first order PDEs: upwinding and monotone schemes, finite difference, finite volume, and discontinuous Galerkin methods; Nonlinear conservation laws: weak solutions and entropy conditions,monotone methods.
**Prerequisite:** Permission of instructor; or one graduate level course in partial differential equations or one graduate level course in numerical analysis or scientific computing.
**Credit Only Granted for:** AMSC612 or AMSC715.
**Formerly:** AMSC612.
**Additional Information:** This course continues AMSC 714, but can be taken independently, and is a complement to the graduate courses MATH 673 and MATH 674 in PDEs, AMSC 666 in numerical analysis, and AMSC 660 and AMSC 661 in scientific computing.

**AMSC721 Mathematical Population Biology (3 Credits)**
Foundational principles for modeling and analysis of real-life phenomena in population biology. Topics include design and analysis of models for general classes of unstructured (single species discrete-time and continuous-time, interacting populations etc.) and structured (spatially-structured, age- structured, sex-structured) population biology models in ecology and epidemiology, dynamics analysis of population biology models (asymptotic stability and bifurcation theory), numerical discretization of continuous-time models, statistical analysis (parameter estimation, uncertainty quantification).
**Prerequisite:** Calculus, differential equations, modeling, linear algebra, familiarity with mathematical software and programming languages (e.g., MATLAB, R, Python etc.); or permission of instructor.
**Cross-listed with:** BIOL721, MATH721.
**Credit Only Granted for:** AMSC721, BIOL721 or MATH721.
**Additional Information:** Open to advanced undergraduates by permission of instructor.

**AMSC760 Applied Statistics Practicum (3 Credits)**
A semester long applied applied statistical project (a minimum 10 hours per week or 120 hours in total), in an internship of collaborative research-laboratory setting working on a substantive applied quantitative project with significant statistical content.
**Prerequisite:** Must have completed one year of graduate study in Applied Statistics.
**Restriction:** Must have project proposal approved by SAC coordinator.

**AMSC761 Applied Statistics Seminar (1 Credit)**
Seminar taught once yearly on a rotating basis by faculty engaged in the Applied Statistics area. Required of AMSC Applied Statistics area doctoral students within one year following the completion of their practicum project, AMSC760, and open only to Applied Statistics Area students. The seminar will include sessions on presentation skills, but will consist primarily of oral presentations of students' past Practicum project results. Students attend throughout the term, give one talk (at least 1/2 hour).
**Recommended:** STAT700 or STAT701; and (STAT740 or STAT741).

**AMSC762 Data Analysis Project (1 Credit)**
This course cannot be used to meet any of the Applied Statistics Area's seminar requirements. Offered yearly, required of and limited to MS non-thesis and doctoral students in Applied Statistics Area, for whom the resulting projects serve as a Qualifying Exam component. After 5-6 lectures or presentations on components of successful data analyses and write-ups, 3-4 sessions will discuss previous student project submissions. The culminating project, to be completed in a two week period between semesters, is an analysis and written report of one of three project choices made available each year to represent a spectrum of realistic applied statistical problems.
**Restriction:** Permission of CMNS-Applied Mathematics department; and permission of instructor.

**AMSC763 Advanced Linear Numerical Analysis (3 Credits)**
Advanced topics in numerical linear algebra, such as dense eigenvalue problems, sparse elimination, iterative methods, and other topics.
**Prerequisite:** AMSC666 or CMSC666; or permission of instructor.
**Cross-listed with:** CMSC763.
**Credit Only Granted for:** AMSC600, AMSC763, CMSC760, or CMSC763.
**Formerly:** AMSC600 and CMSC760.

**AMSC764 Advanced Numerical Optimization (3 Credits)**
Modern numerical methods for solving unconstrained and constrained nonlinear optimization problems in finite dimensions. Design of computational algorithms and the analysis of their properties.
**Prerequisite:** MATH410; or permission of instructor. Cross-listed with C MSC764.
**Credit Only Granted for:** AMSC607, AMSC764 or CMSC764. F ormerly: AMSC607.

**AMSC799 Master's Thesis Research (1-6 Credits)**

**AMSC808 Advanced Topics in Applied Mathematics (1-3 Credits)**
Advanced topics of current interest.
**Restriction:** Permission of instructor.
**Repeatable to:** 18 credits.

**AMSC819 Applied Mathematics Seminar (1-3 Credits)**
Advanced topics of current interest.
**Restriction:** Permission of instructor.
**Repeatable to:** 18 credits.

**AMSC898 Pre-Candidacy Research (1-8 Credits)**

**AMSC899 Doctoral Dissertation Research (1-8 Credits)**