

# AMSC - APPLIED MATHEMATICS & SCIENTIFIC COMPUTATION

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## 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, MATH341, MATH461); 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 minimum grade of C- in STAT400. And 1 course with a minimum grade of C- from (CMSC106, CMSC131); or students who have taken courses with comparable content may contact the department. Cross-listed with MATH420.

**Credit Only Granted for:** AMSC420 or MATH420.

## 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, MATH461, MATH341); and 1 course with a minimum grade of C- from (MATH340, MATH241); and 1 course with a minimum grade of C- from (CMSC106, CMSC131); and minimum grade of C- in MATH246. Also offered as: CMSC460.

**Credit Only Granted for:** AMSC460, CMSC460, AMSC466, 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 (MATH240, MATH461, MATH341); and 1 course with a minimum grade of C- from (MATH340, MATH241); and 1 course with a minimum grade of C- from (CMSC106, CMSC131); and minimum grade of C- in MATH410. Also offered as: 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)

Monte Carlo simulation, numerical linear algebra, nonlinear systems and continuation method, optimization, ordinary differential equations. Fundamental techniques in scientific computation with an introduction to the theory and software of each topic.

**Prerequisite:** Must have knowledge of C or Fortran. And AMSC460 or CMSC460; or (CMSC466 or AMSC466); or (must have knowledge of basic numerical analysis (linear equations, nonlinear integration, interpolation); and permission of instructor). Cross-listed with CMSC660.

**Credit Only Granted for:** AMSC660 or CMSC660.

## AMSC661 Scientific Computing II (3 Credits)

Fourier and wavelet transform methods, numerical methods for elliptic partial differential equations, numerical linear algebra for sparse matrices, Finite element methods, numerical methods for time dependent partial differential equations. Techniques for scientific computation with an introduction to the theory and software for each topic. Course is part of a two course sequence (660 and 661), but can be taken independently.

**Prerequisite:** Must have knowledge of C or Fortran. And CMSC466, AMSC466, AMSC460, or CMSC460; or (must have knowledge of basic numerical analysis (linear equations, nonlinear equations, integration, interpolation); and 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; and (AMSC460, AMSC466, CMSC460, or CMSC466). And (must have knowledge of basic numerical analysis (linear equations, nonlinear equations, integration, interpolation); and permission of instructor). 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, (AMSC663/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:** CMSC660 or AMSC660; and (CMSC661 or AMSC661).

**Restriction:** Permission of instructor. Cross-listed with CMSC663.

**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 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:** AMSC663 or CMSC663.

**Restriction:** Permission of instructor. Cross-listed with CMSC664.

**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. And MATH410; or students who have taken courses with comparable content may contact the department. 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. Also offered as: 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.

**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. Also offered as: 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. Formerly: 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)**