Bowie State University

Department of Mathematics

Master of Science
in
Applied and Computational Mathematics

Certificate
in
Applied and Computational Mathematics

Department of Mathematics
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School of Arts and Sciences
Department of Mathematics

Dean Dr. George Acquaah
Chairperson Dr. Elena Klimova

The program of study leading to the Master of Science degree in Applied and Computational Mathematics is designed to launch you upon a career as a mathematical scientist, firmly prepared from the start to engage in the technical work of today's complex computer-driven industries.

As a graduate of the program, you will emerge equipped with a strong foundation of advanced analytical skills, both in applied mathematics and in computer science. These advanced skills, for which there is a growing demand, will enable you to ascend to the technical career of your choice in industry, business, education, or government.

The curriculum of the program is oriented toward practical applications. The mathematics component of the curriculum consists of seven courses in applied mathematics, four of which are required, and three of which are electives. The computer science component of the curriculum consists of five courses, two of which are required, and three of which are electives.

In addition to the 36 credit hours of regular course work, master's degree program requires each candidate to pass a comprehensive examination based upon the six required core courses.

For your convenience, the program offers a flexible schedule of evening classes, and a generous period of up to seven years to complete the course of study.

Faculty: research and teaching interests:

- K. Benbury abstract algebra, algebraic foundations of quantum mechanics, geometry, probability and statistics, computational mathematics
- M. Etefa fractional calculus, evolution equations, stability and controllability
- E. Klimova differential geometry and topology, gravitational theories, methods of teaching mathematics
- S. LaLonde C*-algebras, group/groupoid crossed products, graph C*-algebras, inverse semigroups, dynamical systems
- Ch. Liu probability theory and stochastic processes, mathematical, statistics, quantum computation and quantum information theory
- M. Mahdavi functional differential equations with abstract Volterra operators, differential equations, real and complex analysis
- R. Sznajder mathematical programming, linear complementarity problem and variational inequalities, linear and nonlinear functional analysis, operations research, numerical analysis

Admissions Policy

The applicant must meet the general admissions requirements established by the Graduate School. Moreover, to be admitted unconditionally to the graduate program in applied and computational mathematics, the applicant must possess a baccalaureate degree in mathematics or closely related field from an accredited institution, and must have had completed the following courses in mathematics and computer science:

1. Calculus sequence
2. Differential Equations
3. Linear Algebra
4. Mathematical Probability and Statistics
5. Programming language C or C++.

Promising applicants not possessing the required mathematics or computer science background could be granted conditional admission subject to completion of these requirements within the first four semesters. Completion of these requirements would be in addition to the regular requirements of the graduate program as outlined in Graduate Program Requirements.

Certificate in Applied and Computational Mathematics

The graduate Certificate in Applied and Computational Mathematics is awarded to students who successfully complete the six core courses, and who, in addition, pass the comprehensive examination at a satisfactory level.

Graduate Fellowships

For more information, please download the application from the graduate website: http://www.bowiestate.edu/academics/graduate_studies/assistantship/

Graduate Program Requirements

The minimum requirements for the master's degree in applied and computational Mathematics are:

1. A minimum of 36 credit hours of course work, as listed in Required and Elective Courses, with an overall grade point average of 3.00 or better.
2. Of the 36 credits of required course work, a minimum of thirty (30) credits must be completed at Bowie State University. Thus, no more than six (6) credits may be transferred from other institutions.
3. All degree requirements must be completed within a period of seven (7) consecutive years.
4. Students must pass the Applied and Computational Mathematics Comprehensive Examination within a maximum of three attempts. The examination questions are based upon the six core courses listed in Required and Elective Courses.

Required and Elective Courses

Core Requirements: 18 Credits

MATH 500 Real Analysis
MATH 525 Ordinary Differential Equations
MATH 540 Operations Research I
MATH 544 Applied Statistics
COSC 504 Software design and development II
MATH 541/COSC 541 Numerical Analysis I

Completion of the above list of six core courses suffices for the graduate Certificate in Applied and Computational Mathematics. For the Master of Science degree, the student must take an additional three courses (9 credits) in Computer Science and an additional three courses (9 credits) in Mathematics selected from the following list of **electives:**

COSC 522 Discrete Structures
COSC 528 Design and Analysis of Algorithms
COSC 565 Software Engineering I
COSC 573 Artificial Intelligence I
MATH 641/COSC 641 Numerical Analysis II
COSC 678 Modeling and Simulations
MATH 580 Applied Queuing Theory
MATH 530 Introduction to Optimization Theory
MATH 550 Applied Complex Analysis
MATH 560 Mathematical Modeling
MATH 570 Coding Theory and Cryptography
MATH 625 Applied Differential Equations
MATH 645 Dynamical Systems
MATH 630 Introduction to Partial Diff. Equations
MATH 640 Operations Research II
MATH 685 Applied Functional Analysis I
MATH 686 Applied Functional Analysis II
MATH 690-695 Selected Topics
MATH 696 Research Project

Mathematics

MATH 500 REAL ANALYSIS **3 Credits**

Prerequisites: Graduate status

This course is a primer in modem mathematical analysis for graduate students in Applied Mathematics. The contents include basic concepts in topology of metric spaces, continuity, differentiation, Riemann-Stieltjes integral, sequences and series of functions, uniform convergence, equicontinuity and power series.

MATH 525 ORDINARY DIFFERENTIAL EQUATIONS **3 Credits**

Prerequisites: MATH 300 and MATH 500

The theory of differential equations is one of the basic tools of mathematical science. The purpose of this course is to study the fundamental concepts of the theory of differential equations, such as: existence, uniqueness, and continuous dependence of solutions on data; linear equations; stability theory and its applications; and periodic and oscillatory solutions. This theory makes it possible to study all evolutionary processes that possess the properties of determinacy, finite-dimensionality, and differentiability. Upon successful completion of this course, the student will have the theoretical understanding and practical knowledge of ordinary differential equations.

MATH 530 INTRODUCTION TO OPTIMIZATION THEORY **3 Credits**

Prerequisites: MATH 500 or MATH 494 or instructor's permission

In this course, mathematical foundations of the optimization theory will be studied. Emphasis will be put on convex analysis, convex programming, and duality theory. Although some algorithms will be reviewed; it is mainly the theory of optimization that will be discussed.

MATH 540 OPERATIONS RESEARCH I **3 Credits**

Prerequisites: MATH 228 or equivalent

This course covers aspects of mathematical programming and its applications. Topics included are linear programming, the simplex method, duality, the transportation problem and other applications, network analysis, and integer programming.

MATH 541/COSC 541 NUMERICAL ANALYSIS I **3 Credits**

Prerequisites: Graduate status

Introduction to the types of problems that require numerical techniques for their solution and examples of error propagation that arise when applying numerical methods. Topics include solutions of equations in one variable using bisection, fixed-point iteration, Newton-Raphson and Müller's methods; interpolation and polynomial approximation; iterative and direct methods of solving linear and nonlinear systems.

MATH 544 APPLIED STATISTICS **3 Credits**

Prerequisites: MATH 342 and MATH 344

The purpose of this course is to give students the background necessary to analyze data in a statistically sound manner. Topics include design of experiments, analysis of variance, time series, non-parametric statistics, linear and multiple regression, and statistical modeling.

MATH 550 APPLIED COMPLEX ANALYSIS **3 Credits**

Prerequisites: MATH 232 or equivalent

The course covers the following topics: analytic functions of a complex variable, harmonic functions and applications to physical problems, contour integration, Taylor, and Laurent expansions, Cauchy integral and residue theorems, conformal mappings.

MATH 560 MATHEMATICAL MODELING **3 Credits**

Prerequisites: Graduate Status
A study of model building processes and the assumptions underlying mathematical models. A sampling of topics includes mathematical models of phenomena in the physical sciences, biology, population dynamics ecology, management science, and the life sciences.

MATH 570 CODING THEORY AND CRYPTOGRAPHY **3 Credits**
Prerequisites: MATH 320 and COSC 504 or instructor's permission
A study of the mathematical problem of representing information with the objective of optimizing the economy and security of storage and transmission. A sampling of topics includes: measures of information, Shannon theory, linear codes, cyclic codes, error-correcting codes, techniques of data compression, cryptosystems, public key cryptography.

MATH 580 APPLIED QUEUING THEORY **3 Credits**
Prerequisites: MATH 342 and MATH 232 or instructor's permission
The development of queuing theory and the application of that theory to discrete simulations in general, and to computer systems, in particular. Topics include random processes, characterization of different queuing systems, the classical single-server exponential queuing model, additional single and multiple-server queuing models, including birth-death processes and finite sources, and the assumptions and limitations of the various queuing models. The application of queuing theory to computer systems is emphasized.

MATH 625 APPLIED DIFFERENTIAL EQUATIONS **3 Credits**
Prerequisites: MATH 525
This course examines advanced topics in ordinary differential equations, including delay differential equations, existence and uniqueness of solutions of second and third order boundary value problems, periodic boundary value problems.

MATH 630 INTRO. TO PARTIAL DIFFERENTIAL EQUATIONS **3 Credits**
Prerequisites: MATH 525
A study of first order partial differential equations (PDE), conservation law, shock application, linear PDEs, the Cauchy problem, canonical form and classification of second order PDEs. The course also includes selected topics from the following: Laplace's equations, harmonic functions, boundary value problems, the wave equation, the initial value problem, the forward light cone, Huyghens' principle, conservation of energy, initial and boundary conditions, the heat equation, heat conduction, the initial-boundary value problem, finite differences, and finite elements.

MATH 640 OPERATIONS RESEARCH II **3 Credits**
Prerequisites: MATH 540
This course introduces stochastic models of operations research. Topics include Markov chains, queuing theory, forecasting, Markovian decision processes, decision analysis, and simulation.

MATH 641/COSC 641 NUMERICAL ANALYSIS II **3 Credits**
Prerequisites: MATH 541/COSC 541
This course is a continuation of MATH 541/COSC 541. The topics include numerical differentiation and integration, the solution of initial and boundary value problems for ordinary differential equations, methods of solving nonlinear systems of equations; other topics as time permits.

MATH 645 DYNAMICAL SYSTEMS

This course is an introduction to nonlinear dynamics and chaos. Topics to be covered include: Discrete and continuous time linear systems; one dimension, two and more dimensions. Nonlinear systems; fixed points, stability, linearization, periodicity, bifurcation, and chaos. Fractals; Cantor's set, contraction maps. Iterated function systems, complex dynamical systems.

MATH 685 APPLIED FUNCTIONAL ANALYSIS I

Prerequisite: MATH 500

This course provides a foundation of functional analysis and its applications. The course covers metric spaces, normed and Banach spaces, linear operators, inner product and Hilbert spaces, fundamental theorems for normed and Banach spaces, and application of Banach's theorem to differential and integral equations.

MATH 686 APPLIED FUNCTIONAL ANALYSIS II

Prerequisite: MATH 685

This course is a continuation of MATH 685. It covers approximation theory, spectral theory of linear operators in normed spaces, compact linear operators on normed spaces and their spectrum, spectral theory of bounded self-adjoint linear operators, and unbounded linear operators in Hilbert spaces.

MATH 690-695 SELECTED TOPICS **3 Credits**

MATH 696 RESEARCH PROJECT **3 Credits**

Computer Science

COSC 504 DATA SOFTWARE DESIGN AND DEVELOPMENT II **3 Credits**

Prerequisites: COSC 404 or instructor's permission

Topics include preprocessor facilities, storage, pointer variables, direct I/0, and recursion; data structures, such as stacks, queues, circular lists, linked lists, trees, and graphs. Algorithms for searching, sorting, merging, hashing; system functions such as compiling, link editing, and libraries.

COSC 522 DISCRETE STRUCTURES **3 Credits**

Prerequisites: Graduate status

This course includes a survey of those areas in mathematics that are particularly useful to computer science. Topics discussed include set theory, relations and functions, equivalence and order relations, digraph and trees, and probability concepts.

COSC 528 DESIGN AND ANALYSIS OF ALGORITHMS **3 Credits**

Prerequisites: COSC 504 and COSC 522

This course includes discussion of design and analysis of basic computer algorithms based on the Following techniques: divide-and-conquer, greedy, dynamic programming, tree and graph traversals, backtracking, and branch-and-bound method. Applications to problems, such as sorting and searching, traveling salesman, knapsack, graph coloring, set union-and-find, matrix multiplication, and scheduling. Use of advanced data structures appropriate for different techniques and problems. Use of mathematical tools, such as big-oh notation and recurrence relations in the analysis of algorithms to NP-completeness and discussion of P=NP question.

COSC 565 SOFTWARE ENGINEERING I **3 Credits**

Prerequisites: COSC 504

This course introduces the student to major topics in software engineering such as: requirement specification, analysis and design, testing, project management, and implementation. Additional topics such as software life cycle models, the Unified Modeling Language (UML), agile software development techniques, configuration management, change control, and project documentation will be discussed.

COSC 573 ARTIFICIAL INTELLIGENCE **3 Credits**

Prerequisites: COSC 528

This course is an introduction to artificial intelligence. Topics include knowledge acquisition and representation, heuristic search methods, logical and probabilistic reasoning, expert system architecture, and AI applications in languages such as LISP and PROLOG.

COSC 678 MODELING AND SIMULATIONS **3 Credits**

Prerequisites: COSC 504 and COSC 522

A study of construction of models that simulate real systems. The methodology of solution should include probability and distribution theory, statistical estimation and inference, the use of random variables, and validation procedures. A simulation language should be used for the solution of typical problems.

Call: Graduate School, phone: (301) 860-3406
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