CMPSC/MATH 455
Introduction to Numerical Analysis I

Catalog Data: Introduction to Numerical Analysis I (3)
Floating point computation, numerical rootfinding, interpolation, numerical quadrature, direct methods for linear systems. Students may take only one course for credit from CMPSC/MATH 451 and CMPSC/MATH 455. Prerequisite: MATH 220; MATH 230 or MATH 231; and 3 credits of programming.

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Course Objectives: CMPSC/MATH 455 introduces the ideas behind numerical analysis. Topics include floating point number systems, use of Taylor series expansions, solution of linear and nonlinear equations, interpolation, numerical integration and differentiation, and the numerical solution of ordinary differential equations. The topic list is similar to CMPSC/MATH 451, but there is more emphasis upon the computational mathematics behind the numerical methods and upon proving theorems. The course also sets up material in CMPSC/MATH 456, Numerical Analysis II.

Primary Course Outcomes: Upon completion of the course, students should possess the following skills:

- Floating Point Arithmetic: An understanding of IEEE Standard P754 arithmetic and appreciation of the difference between solving a problem in real arithmetic and in floating point arithmetic.
- Systems of Equations: The ability to design algorithms and codes for the solution of linear systems of equations. Also the concepts of norms, errors, and conditioning should be understood. An understanding of how to localize the solution of a nonlinear equation and how to convert one into a sequence of linear equations using Newton-like methods.
- Mathematical Understanding: The ability to perform simple proofs about the properties of numerical methods.

Relationship to Undergraduate Program Outcomes: CMPSC/MATH 455 supports the following program outcomes:

- Demonstrate an ability to analyze the space/time complexity of algorithms using discrete mathematics, including the appropriate use of O-notation and recurrence relations.
- Develop a modest (on the order of a thousand lines of code) software application, using appropriate data structures or algorithms.
- Analyze algorithms or computer code for correctness and efficiency.

Required Topics: (38 hrs. total)
Floating Point Arithmetic and Taylor series (~2 hrs)
Systems of linear equations. (~9 hrs)
Nonlinear Equations (~4 hrs)
Interpolation including splines and FFTs. (~9 hrs)
Numerical Integration and Differentiation. (~7 hrs)
Numerical Solution of Ordinary Differential Equations (~7 hrs)

Class Format: Three lectures per week. Each lecture is 50 minutes.
Professional Component: CMPSC/MATH 455 is designed to aid in the professional development of engineers and scientists by developing skills in numerical problem solving, critical mathematical thinking, algorithm design, and numerical software development.

Evaluation:
- 30% unproctored assignments (problem sets and programming projects)
- 40% proctored midterm exams
- 30% proctored Final Exam

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