AMS 326 - Numerical Analysis

Summer 2024

Instructor:	Wenhan Gao
Time:	Tuesday & Thursday, 6:00 – 9:25 PM
Location:	Remote through Zoom
Number of Credits:	3
Email:	wenhan.gao@stonybrook.edu
Office Hours:	Wenhan: Tuesday & Thursday, 5:00 – 6:00 PM, Zoom

Course Description: This course provides a comprehensive introduction to numerical analysis, focusing on both traditional methods and their implementation using modern computer programming. Students will develop essential skills for utilizing computational techniques to solve problems in computational mathematics, finance, and engineering. This course covers direct and indirect methods for the solution of linear and nonlinear equations, computation of eigenvalues and eigenvectors of matrices, quadrature, differentiation, and curve fitting, and numerical solutions of differential equations.

Prerequisites: AMS 161; basic skills in using a high-level programming language (C, C++, or Java); AMS 210 or MAT 211 (advisory).

Required Textbook: None; Lecture notes will be provided.
Optional/Recommended Textbook: Numerical Analysis by Timothy Sauer; 3rd edition, 2017, Pearson Publishing; ISNB: 978-0134696454

Learning Outcomes:

1. Demonstrate knowledge of the foundational notions of numerical analysis, including basic computer science on storing and manipulating numbers, on finite precision of arithmetic calculations, on the definition of errors and condition number.
2. Demonstrate knowledge of interpolating data using polynomials or trigonometric functions and applying those interpolations to estimate, differentiate, and integrate functions.
3. Demonstrate knowledge of solving systems of algebraic equations using a variety of methods, including iterative ones, leveraging the methods on numerical linear algebra.
4. Demonstrate proficient knowledge of solving ordinary differential equations and their systems, both as initial value problems and as boundary value problems.
5. Demonstrate basic understanding of numerical optimizations and of simple Monte Carlo methods.
6. Demonstrate basic understanding of the numerical aspects of Fourier transforms.

Tentative Course Topics:

- Introduction to Numerical Computation and Computer Arithmetic ($\sim$ 0.5 lecture)
- Polynomial Interpolation and Splines ($\sim$ 1.5 lectures)
- Numerical Integration ($\sim$ 1 lectures)
- Numerical Solutions of Non-linear Equations ($\sim$ 1 lectures)

- Direct Methods for Systems of Linear Equations ($\sim$ 1.5 lectures)
- Fixed Point Iterative Solvers for Linear Systems ($\sim$ 1.5 lectures)
- Numerical Solutions of ODEs ($\sim$ 1.5 lectures)
- Numerical Optimizations and Fast Fourier Transforms ($\sim$ 1.5 lectures)
- (If time allows) Finite Difference for Partial Differential Equations

Course Format and Grading Policy: The course will be conducted online through Zoom; however, attendance is still expected. Homework will be assigned approximately weekly and will be due at least a week after it is given. The homework will involve the implementation of numerical methods taught in class, and a short written report that includes your results is required. All lecture notes and coding examples will be provided as Jupyter notebooks (Python). However, all programming languages are allowed for the homework, provided your scripts are directly runnable without interpretation or compilation errors. Grades will be assigned based on the quality and correctness of the code and reports. There will be an open-book coding midterm exam similar to the format of the homework and a final exam that consists of a closed-book written part on the understanding of concepts and numerical methods taught in class, and an open-book coding part similar to that of the midterm.

Homeworks	45%
Midterm Exam	20%
Final Exam	35%

Student Accessibility Support Center: If you have a physical, psychological, medical, or learning disability that may impact your course work, please contact the Student Accessibility Support Center, Stony Brook Union Suite 107, (631) 632-6748, or at sasc@stonybrook.edu. They will determine with you what accommodations are necessary and appropriate. All information and documentation is confidential.

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty is required to report any suspected instances of academic dishonesty to the Academic Judiciary. Faculty in the Health Sciences Center (School of Health Professions, Nursing, Social Welfare, Dental Medicine) and School of Medicine are required to follow their school-specific procedures. For more comprehensive information on academic integrity, including categories of academic dishonesty please refer to the academic judiciary website at `https://www.stonybrook.edu/commcms/academic_integrity/index.html`.

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Student Conduct and Community Standards any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn. Faculty in the HSC Schools and the School of Medicine are required to follow their school-specific procedures. Further information about most academic matters can be found in the Undergraduate Bulletin, the Undergraduate Class Schedule, and the Faculty-Employee Handbook..