University at Buffalo
The State University of New York

MTH 537: Introduction to Numerical Analysis 1
Fall 2022

Course Information

Instructor: Name: Dane Taylor
Office: Math 311
Office Hours: Wed at 9:30-10:50am
Email: danet@buffalo.edu

Lecture Information: Time & Location: T/Th@9:30am in Room: Mathematics 122

To manage grades, communications, and HW we will use
UBLearns: https://ublearns.buffalo.edu/
Piazza: https://piazza.com/buffalo/fall2022/mth537 access code: BUF
Gradescope: https://www.gradescope.com/courses/430844 entry code: 4VJY86

Course Textbooks

Required: *Classical and Modern Numerical Analysis*. By A. S. Achleh, E. D. Allen, R. B. Kearfott, and P. Seshaiyer. CRC Press (2010).
Optional: *An Introduction to Numerical Analysis*, 2nd Edition, by Kendall E. Atkinson

Course Requirements

Attendance: Attendance for lectures is mandatory. You are responsible for all information conveyed during the lectures, which might cover additional material not found in the textbook. If for some reason you must miss a class, you must discuss with me in advance. You will be responsible for learning the material covered during class. Classes missed due to illness require a note from your doctor.

Homework: Homework will be assigned each Thursday of most weeks and will be due the following Wednesday at 11:59PM. Late homework is not accepted.

Exams: There will be two in-class midterms and a final. No notes or calculators.

Midterm 1 – week 6 (material covered in chapters 1-3)
Midterm 2 – week 12 (material covered in chapters 4-5)
Final – during finals week. Not yet scheduled. (material covered in chapters 1-6)

Programming: Weekly and bi-weekly assignments will include theoretical and computational problems. You must use Python 3.7 or higher. We will primarily use the Python libraries NumPy, SciPy, and Matplotlib, which are free open-source software that can be downloaded:

- Mac and Windows users: get the Anaconda distribution of Python.
- Linux users: *sudo apt-get install python-numpy python-matplotlib python-scipy python-sympy*

There will be absolutely no non-class-related use of computers (this includes tablets and phones) during class - each infraction will cost you a 5% reduction in your overall class grade.

GRADING POLICY

Grades will be weighted according to:

40% Homework
15% Midterm 1
15% Midterm 2
30% Final Exam

I will use, as a minimum, the following grading scale:

A (93-100), A- (90-92), B+ (87-89), B (83-86), B- (80-82),
C+ (77-79), C (73-76), C- (70-72), D+ (67-69), D (64-66).

IMPORTANT DATES

- August 30 – First class
- October 6 – Midterm 1
- November 17 – Midterm 2
- December ? – Final exam – tbd during exam week

LEARNING OUTCOMES

(1) Demonstrate an understanding of algorithms of numerical analysis methods and underlying mathematical underpinnings.
Methods of Assessment: homework, midterm exams, final exam

(2) To be able to code several of the algorithms in Python, and interpret and explain the obtained numerical results.
Methods of Assessment: homework

TENTATIVE SCHEDULE

Week 1: Chapter 1: Mathematical review and computer arithmetic
- Mathematical review (Section 1.1)
- Computer arithmetic (Section 1.2)

Weeks 1-2: Chapter 2: Numerical solution of nonlinear equations of one variable
- Bisection method (Section 2.2)
- Fixed point method (Section 2.3)
- Newton's method (Section 2.4)
- Secant and Müller's methods (Section 2.6)
- Roots of polynomials (Section 2.8)

Weeks 3-6: Chapter 3: Numerical linear algebra
- Basic results from linear algebra (Section 3.1)
- Normed linear spaces (Section 3.2)
- Direct methods for solving linear systems (Section 3.3)

- Iterative methods for solving linear systems (Section 3.4)
- Singular value decomposition (Section 3.5)

Weeks 7-10: Chapter 4: Approximation theory
- Inner product spaces and orthogonalization (Section 4.2)
- Polynomial approximation (Section 4.3)
- Piecewise polynomial approximation (Section 4.4)
- Trigonometric approximation (Section 4.5)
- Least Squares Approximation on a finite point set (Section 4.8)

Week 11-12: Chapter 5: Eigenvalue-eigenvector computation
- Basic results from linear algebra (Section 5.1)
- Power method (Section 5.2)
- Inverse power method (Section 5.3)
- Deflation (Section 5.4)

Weeks 14-15: Chapter 6: Numerical differentiation and integration
- Numerical differentiation (Section 6.1)
- Automatic differentiation (Section 6.2)
- Numerical integration (Section 6.3)

ACADEMIC INTEGRITY

Academic integrity is a fundamental university value. Through the honest completion of academic work, students sustain the integrity of the university while facilitating the university's imperative for the transmission of knowledge and culture based upon the generation of new and innovative ideas. For a full description of the Undergraduate Academic Integrity Policy, see the following webpage: http://undergrad-catalog.buffalo.edu/policies/course/integrity.shtml

ACCESSIBILITY RESOURCES

If you have any disability which requires reasonable accommodations to enable you to participate in this course, please contact the Office of Accessibility Resources, 25 Capen Hall, 645-2608, and also the instructor of this course. The Office of Accessibility Resources (http://www.student-affairs.buffalo.edu/ods/) will provide you with information and review appropriate arrangements for reasonable accommodations.

CRITICAL CAMPUS RESOURCES

Sexual Violence

UB is committed to providing a safe learning environment free of all forms of discrimination and sexual harassment, including sexual assault, domestic and dating violence and stalking. If you have experienced gender-based violence (intimate partner violence, attempted or completed sexual assault, harassment, coercion, stalking, etc.), UB has resources to help. This includes academic accommodations, health and counseling services, housing accommodations, helping with legal protective orders, and assistance with reporting the incident to police or other UB officials if you so choose. Please contact UB's Title IX Coordinator at 716-645-2266 for more information. For confidential assistance, you may also contact a Crisis Services Campus Advocate at 716-796-4399.

Mental Health

As a student you may experience a range of issues that can cause barriers to learning or reduce your ability to participate in daily activities. These might include strained relationships, anxiety, high levels of stress, alcohol/drug problems, feeling down, health concerns, or unwanted sexual experiences. Counseling, Health Services, and Health Promotion are here to help with these or other issues you may experience. You can learn more about these programs and services by contacting:

Counseling Services:

- 120 Richmond Quad (North Campus), 716-645-2720
- 202 Michael Hall (South Campus), 716-829-5800

Health Services:

- Michael Hall (South Campus), 716-829-3316

Health Promotion:

- 114 Student Union (North Campus), 716-645-2837