Syllabus, Spring 2024

MA 468/568-Numerical Analysis I
(Location: UH 2005, Time: 08:00 am-08:50 am MWF)

Instructor Information:

Name: Dr. Muhammad "Jaman" Mohebujjaman

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Office Hours: Mondays and Wednesdays: 9:10 am-10:10 am or by appointment.

Preferred Methods of Contact: Email is the preferred method of contact if you have questions. Please expect a response within 24 hours on weekdays and a slower response on weekends (or emails received after 5 pm on Friday will be returned Monday morning). Include the course name and number in the subject line of your email for a faster response.

Course Material:

Text: A First Course in Numerical Methods by Uri M. Ascher and Chen Greif.

Other good books:

1. Scientific Computing: An Introductory Survey, Second Edition by Michael T. Heath.

2. Numerical Linear Algebra by William Layton and Myron Sussman.

3. Numerical Linear Algebra by LLoyd N. Trefethen and David Bau, III.

4. Numerical Linear Algebra with Applications by William Ford.

Course Description, Objectives and Prerequisite:

Sources of error and conditioning. Solution of algebraic equations in one variable: Bisection method, Fixed point iteration method, Newton's method and its variants, and their convergence. Approximation and interpolation: Monomial and Lagrange interpolations, Newton's divided difference form, Hermite interpolation, and Cubic spline. Numerical differentiation: Deriving formulas using Taylor series, Truncation error, and Richardson extrapolation. Numerical integration: Open and closed Newton-Cotes formulas, Composite numerical integration, Romberg integration, and Gaussian quadrature. Solution of Ordinary Differential Equations (ODEs): Initial value ODEs, Euler's method, Runge-Kutta methods, Multi-step methods, and Boundary value ODEs. Practice on the computer.

This course will be useful for mathematics, computer science, physics, and engineering students in many ways. It is a programming-based scientific computing course. Students will have hands-on experience with problems where computers make unavoidable errors. This course is the foundation of artificial intelligence, data science, and advanced computing techniques, e.g., finite element method, finite difference method, uncertainty quantification, and many more. Students will have plenty of opportunities to learn various programming languages (python recommended) and solve scientific problems with them.

Prerequisites: MA 227 [Min Grade: C] or MA 252 [Min Grade: C]

Student Learning Outcomes:

Upon successful completion of this course, students will be able to:

- Write computer programs using various languages, e.g., Python (Recommended), Matlab, C++, etc, for solving scientific problems.

- Learn about numerical algorithms in scientific computing, the errors in the numerical algorithms, the properties of algorithms.

- Understand the "roundoff error" which is the most fundamental source of imperfection in numerical computing and arises because of the intrinsic limitation of the finite precision representation of numbers in computers.

- Know about various polynomial interpolations, e.g., Monomial interpolation, Lagrange interpolation, Divided difference, and Newton's form. They will also be able to find error estimates in polynomial interpolations.

- Solve initial value Ordinary Differential Equations (ODEs) numerically using various techniques such as Euler's method, Runge-Kutta methods, and multi-step methods. Solve boundary value ODEs.

- Know about integration schemes: Basic quadrature formulas, composite numerical algorithms, Gaussian quadrature, etc.

Grading:

The final grade will be a weighted average and will be calculated as below:
Homework: 25%   **Exam I:** 25%   **Exam II:** 25%   **Final Exam:** 25%

Homework Policy:

It is expected that the source code used to generate outcomes will be attached to the homework on or before the due date.

Grading Scale:

A: [90,100]; B: [80,90);   C:[70,80);   D:[60,70), F:[0,60)

Tentative Exam Dates:

Exam 1: Friday, 02/09/2024, **Exam 2:** Friday, 03/08/2024, **Final Exam:** TBD.

Make-Up Exams:

There will be NO make-up exams except for the observance of a religious holiday or for an official university absence.

General Course Policies

- No cell phones or other electronic devices will be allowed on your person during quizzes or exams.

- Be respectful of yourself, and others in the course.

- While explaining, you should not talk to anyone in class except me.

- Feel free to ask me any questions in class or outside of class.

Classroom Attendance Rule

Students are expected to attend all the classes unless they have a valid acceptable excuse.