Syllabus, Fall 2024

MA 668-1C-Numerical Analysis I
(UH 4002, 10:10 am-11:00 am MWF)

Instructor Information:

Instructor Name: Dr. Muhammad "Jaman" Mohebujjaman

Email: mmohebuj@uab.edu **Office:** UH 4045 **Office Phone:** 205-934-2195
Office Hours: Mondays and Wednesdays: 11:10 am-12:10 pm 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 LLoyd N. Trefethen and David Bau, III.

Course Description, Objectives and Prerequisite:

Iterative solution of algebraic equations in one variable: Bisection method, Fixed point iteration method, and Newton's method and it variants. Review of linear algebra background: Basic concept of linear algebra, Vector and matrix norms, Special classes of matrices: Symmetric positive definite matrices, Orthogonal vectors and matrices, and Singular values. Direct methods for solving linear systems: Gaussian elimination, LU decomposition, Pivoting strategies, Cholesky decomposition, Computational complexity, Sparse matrix, Permutation and ordering strategies, Estimating errors and condition number. Linear least squares problems: Normal equations. Polynomial interpolation: General approximation and interpolation, Monomial, Lagrange, and Newton's divided difference polynomial interpolations, Chebyshev interpolation, Piecewise polynomial interpolation and their error analysis. Numerical integration: Basic quadrature algorithms, Composite numerical integration, Gaussian and Adaptive quadrature, and their error analysis. Numerical solution of ordinary differential equations: Euler's method, Multistep methods, stability and stiffness, Explicit vs. implicit methods, Truncation error, and Order of convergence. Hands-on experience on numerical techniques. Prerequisites: MA 670 (Min Grade: B)

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.
- Solve nonlinear single variable algebraic equations using various iterative methods: Bisection method, Fixed point iteration method, Newton's method, and its variant.
- Solve linear systems using Gaussian elimination (Direct Solver), backward substitution, and pivoting strategies.
- Know about least square minimization problems, and their solving strategies using the normal equations.
- 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 algorithm, Gaussian quadrature, etc.
- Rational approximation.

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 typed 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: Wednesday, October 02, 2024, 10:10 am-11:00 am, **Exam 2:** Friday, November 01, 2024, 10:10 am-11:00 am, **Final Exam:** Friday, December 13, 8:00 am-10:30 am.

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.