OFFICIAL SYLLABUS
465-NUMERICAL ANALYSIS
Adopted - Fall 2018 (Committee: Drs. Leem, Liu, Sewell, Song)

Catalog Description: Error analysis, solution of nonlinear equations, interpolation, numerical differentiation and integration, numerical solution of ordinary differential equations, solution of linear systems of equations.

Prerequisites: Math 223, 305, CS 145 with a grade of C or better or consent of instructor

Textbook: Fundamentals of Numerical Computation, by Tobin A. Driscoll and Richard J. Braun
ISBN 978-1-611975-07-9

Course Outline:

Chapter 1, Numbers, problems, and algorithms
1.1 Floating point numbers
1.2 Problems and conditioning
1.3 Stability of algorithms

Chapter 2, Square linear systems (Optional)
2.3 Linear systems (Optional)
2.4 LU factorization (Optional)
2.6 Row pivoting (Optional)

Chapter 4, Roots of nonlinear equations
4.1 The rootfinding problem
4.2 Fixed point iteration
4.3 Newton's method in one variable
4.4 Interpolation-based methods

Chapter 5, Piecewise interpolation and calculus
5.1 The interpolation problem
5.2 Piecewise linear interpolation
5.3 Cubic splines
5.4 Finite differences
5.5 Convergence of finite differences
5.6 Numerical integration
5.7 Adaptive integration

Chapter 6, Initial-value problems for ODEs
6.1 Basics of IVPs
6.2 Euler's method
6.3 Systems of differential equations
6.4 Runge–Kutta methods
6.5 Adaptive Runge–Kutta
6.6 Multistep methods
6.7 Implementation of multistep methods

Chapter 9, Global function approximation
9.1 Polynomial interpolation
9.6 Spectrally accurate integration

Learning Objectives

The primary goal is to provide students with a basic knowledge of numerical methods including: root-finding, interpolation, numerical differentiation and integration, and numerical solution to ordinary differential equations. MATLAB is the software environment used for implementation and application of these numerical methods. The numerical techniques learned in this course enable students to work with mathematical models of technology and systems.

Objective 1

Understand the implications of digital number representation and digital arithmetic for computational science and engineering.

- Outcome 1.1: Understand the fundamental principles of digital computing, including number representation and arithmetic operations.
- Outcome 1.2: Understand the linkage between accuracy, stability and convergence.
- Outcome 1.3: Perform error analysis for arithmetic operations.
- Outcome 1.4: Understand the propagation of errors through complex numerical algorithms.
- Outcome 1.5: Perform numerical stability analysis.

Objective 2

Develop and implement numerically stable and accurate algorithms for all the basic tasks of computational science and engineering:

- Outcome 2.1: Develop efficient and stable algorithms for finding roots of non-linear equations.
- Outcome 2.2: Develop robust and stable algorithms for numerical differentiation and integration.
- Outcome 2.3: Understand the use of interpolation for numerical differentiation and integration as well as in function approximation.
- Outcome 2.4: Develop stable solution algorithms for ordinary differential equations.