

3450:427/527, Applied Numerical Methods I
Course Outline

1. Computer Arithmetic and Errors
 - A. Examples of numerical errors
 - B. MATLAB interlude
 - C. Machine representation of numbers
 - D. Computations
 - a. Types of error
 - b. Sample machine calculation
 - c. Cancellation error
 - d. Algebraic manipulations to reduce cancellation
 - e. Propagation of errors
 - f. Backward recurrence
 - g. Overflow
 - h. Series convergence
 - E. Recurrence Relations and Stability
 - a. Recurrence relations
 - b. Backward recurrence
 - c. Overflow
2. Root Finding
 - A. Introduction
 - B. Methods
 - a. Bisection method
 - b. Newton's method
 - c. Secant method
 - d. Fixed point method
 - C. Algorithms and Code
 - a. Stopping criteria
 - b. Bisection – separate files and embedded functions
 - c. Secant method
 - D. Applications
3. Numerical Linear Algebra
 - A. Introduction
 - a. Goal
 - b. Solvability
 - c. Special matrix structures
 - d. Examples
 - B. MATLAB interlude

- C. Direct algorithms
 - a. Upper triangular systems
 - b. Gauss Elimination
 - c. Pivoting
 - d. MATLAB backslash command
 - D. Iterative Algorithms
 - a. Jacobi iteration
 - b. Gauss-Seidel iteration
 - E. Nonlinear systems (Newton's method)
4. Polynomial Approximation and Interpolation
- A. Introduction
 - B. Polynomials in MATLAB
 - C. Taylor Series
 - a. Formulas
 - b. Taylor Remainder error theorem
 - c. Error estimates
 - D. Lagrange interpolating polynomials
 - a. Formulas
 - b. Interpolation error theorem
 - c. Error estimates
 - E. Newton polynomials
 - a. Formulas
 - b. Divided differences
 - F. Padé approximation
 - G. Chebyshev interpolation
 - H. Hermite interpolation
 - I. Applications
5. Curve Fitting and Splines
- A. Introduction
 - B. Linear least squares
 - a. Linear regression
 - b. Polynomial regression
 - c. Other linear models
 - C. Nonlinear least squares
 - a. Options
 - b. Choosing a model

- D. Physical models
 - a. Linear: wind chill factor
 - a. Nonlinear: NMR titration
- E. Linear and cubic splines

6. Quadrature

- A. Introduction
- B. Newton-Cotes rules
 - a-f. Rules
 - g. Example
 - h. Degree of accuracy
 - i. Error expressions
- C. Composite rules
 - a. Approach
 - b. Composite Trapezoid
 - c. Composite Simpson
 - d. Examples
- D. Gaussian quadrature
 - a. Approach
 - b. 2 point rule
 - c. n point rules
 - d. Change of interval formula
 - e. Composite n point rules
- E. Adaptive quadrature
- F. Romberg iteration