Aims of course

- Formulate numerical methods for approximation, integration, eigenproblems and ODEs.
- Evaluate numerical methods with respect to their convergence, stability, and efficiency.
- Develop and practice computer skills in implementing numerical methods efficiently on the computer.
- Use high level software for studying numerical methods.

Skills / Knowledge testing in the course

- Apply basic principles, not recall lecture notes in detail
- Problem recognition
- Method recognition
- Apply a given method correctly
- Solve a numerical problem efficiently and reliably using mathematical software.
- Judge the quality and efficiency of the results.

Prerequisite Mathematics and Numerical Analysis

- Ability to handle notation and to do algebraic manipulation
- Induction
- Calculus including differentiation and integration of polynomial, trigonometric, exponential, logarithmic and rational functions, continuity, limits, graphs of functions, Taylor series, Rolle’s theorem, mean-value theorem, de l’ Hospital’s rule, some exposure to multivariate differentiation, etc.
- Elementary Linear Algebra including: Matrix and vector addition and multiplication, elementary row operations, linear (in)dependence, inverse matrix, etc.
- Numerical Linear Algebra (such as CSC336 or CSC350) including:
  - Linear solvers for banded matrices
  - Nonlinear equations solvers
- Computational methods: Understanding of round-off error, computer arithmetic, etc.
- Programming: knowledge of some programming language, such as MATLAB, FORTRAN or C.

Computer accounts

You will get (or have already) a computer account on the CDF Unix system. Consoles/workstations are located in the Bahen building. You must log-in frequently and read mail, news and other messages relating to the course through your account.

Marks distribution

- Assignment 1: Due Thursday, October 15 12% • Must get at least 33% in the final exam.
- Term test: Thursday, October 29 24% • Must get at least 33% average in the computer assignments.
- Assignment 2: Due Monday, November 16 12% • Midterm test and Final exam: Calculators are the only aids permitted.
- Assignment 3: Due Wednesday, December 9 12%
- Final exam: 2 hours 40%

Note: Must get at least 33% in the final exam and 33% average in the computer assignments.
Problem sets / Computer assignments

- Please write as clearly as possible.
- Indicate your last (family) name by capitalisation or underlining in the front page of your paper.
- Computer assignments: don’t leave it to the last minute - think of the following:
  - The machine being down, when you need it.
  - The workstation room being crowded.
  - The printer being stuck, when you are just at the time to get your final listing.
  - Accidentally deleting an important file.
- Overcome this by using backup procedures (for the source and data files only).
- The above are not good reasons for extension of the assignment due date.

Late assignment policy

Assignments are due the day posted, at lecture time. Assignments submitted late have a reduction of marks based on the maximum total marks the assignment could get, had it been submitted on time (and not on the total marks the assignment actually got). Each day costs 10%, to a maximum of 5 days. Assignments submitted later than 5 days after the due date do not receive any marks. Weekends and holidays count as regular days for the purpose of late assignment policy.

Topics to be covered

- Interpolation (Ch. 7)
  - Polynomial interpolation - Weierstrass theorem
  - Monomial basis, Lagrange basis, Newton’s divided differences
  - Existence and uniqueness of interpolating polynomial
  - Error of polynomial interpolation
  - Evaluation of a polynomial - Horner’s rule
  - Polynomial interpolation with derivative data - Hermite interp.
  - Monomial basis, Lagrange basis, Newton’s divided differences
  - Existence and uniqueness of Hermite interpolating polynomial
  - Error of Hermite polynomial interpolation
  - Problems with polynomial interpolation - Runge’s function
  - Piecewise polynomial interpolation - splines
  - Basis for piecewise polynomials
- Least Squares Approximation (Ch. 3)
  - Least squares problems - data fitting
  - Inner products and norms of functions
  - Normal equations, QR factorisation, Gram-Schmidt algorithm
  - Orthogonal and orthonormal polynomials
- Computing eigenvalues and eigenvectors (Ch. 4)
  - The power method; the QR iteration
- Integration -- Quadrature (Ch. 8)
  - Simple quadrature rules - rectangle, midpoint, trapezoidal, Simpson’s, corrected trapezoidal
  - Gauss quadrature rules
  - Compound quadrature rules
  - Romberg integration
  - Adaptive integration
  - Infinite integrals, singularities
- Ordinary Differential Equations (Ch. 9)
  - Initial Value Problems and Boundary Value Problems
  - Stability of ODEs and of methods for ODEs
  - Euler’s method
  - Implicit methods, backward Euler’s and trapezoidal method
  - Runge-Kutta methods
  - Taylor’s series methods
  - Linear Multistep Methods

Other references

- David Kincaid and Ward Cheney, Numerical Analysis, Brooks/Cole
- James Epperson, An introduction to Numerical Methods and Analysis, Wiley 2003
- L. W. Johnson and R. D. Riess, Numerical Analysis, Addison Wesley
- S. D. Conte and Carl de Boor, Elementary Numerical Analysis, McGraw-Hill Inc.
- G. Dahlquist and A. Bjorck (trans. N. Anderson), Numerical Methods, Prentice Hall
- J. Stoer and R. Bulirsch, Introduction to Numerical Analysis, Springer Verlag

I have ordered a custom-made copy of the Heath book that costs about $75, at the UT Bookstore. This is the same book used for CSC350 and CSC336. The Heath book covers most of the material of CSC436. Books such as the Kincaid and Cheney and the Burden and Faires books, cover similar material (some topics are more condensed than the Heath one, and some more expanded). It may be useful to consult these other books occasionally. All these books are reserved in the library.