Lecturer : Christina Christara (ccc@cs.toronto.edu)
Lectures : Wednesday 1-3 PM, Room WB 119
Tutorial : Friday 1-2 PM, Room WB 119 (some tutorials used for lectures)
Office Hours : Tuesday 3:30-4:30pm, Room BA 4226, other hours by appointment
Textbook : Michael Heath, Scientific Computing: an introductory survey, SIAM 2018
available from the SIAM website, cheaper if you become student member, see details in course website below
alternative : Uri Ascher and Chen Greif, A first course in Numerical Methods, SIAM 2011 (e-book on library)
Web site : http://www.cs.toronto.edu/~ccc/Courses/436.html
Bulletin board : https://bb-2022-09.teach.cs.toronto.edu/c/csc436

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 numerical 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 and Nonlinear equations solvers

Computational methods: Understanding of round-off error, computer arithmetic, etc.

Programming: knowledge of some programming language, such as MATLAB, python, FORTRAN or C.

Computer accounts

You will get (or have already) a computer account on the Teaching Labs (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	Fri 14 Oct	20%
Test 1	Fri 28 Oct	20%
Assignment 2 Due	Wed 16 Nov	20%
Test 2	Fri 25 Nov	20%
Assignment 3 Due	Thu 8 Dec	20%

• Must get at least 30% in each of the tests, in **each** of the other assessments; can't skip any
• Must get at least 33% average in the computing parts of the assignments.
• **Term tests**: Calculators and course materials are the only aids permitted.

Problem sets / Computer assignments

problem sets: 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 2 days. Assignments submitted later than 2 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
- 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
- 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

References

Michael Heath
Scientific Computing: an introductory survey
SIAM 2018 (or McGraw-Hill Inc. 2002)

Uri Ascher and Chen Greif
A first course in Numerical Methods
SIAM 2011 (e-book on library)

Richard L. Burden and J. Douglas Faires
Numerical Analysis
Brooks/Cole

David Kincaid and Ward Cheney
Numerical Analysis
Brooks/Cole

James Epperson
An introduction to Numerical Methods and Analysis
Wiley 2003

Samuel D. Conte and Carl de Boor
Elementary Numerical Analysis
SIAM 2018 (also McGraw-Hill Inc.)

L. W. Johnson and R. D. Riess
Numerical Analysis
Addison Wesley

G. Dahlquist and A. Bjorck (trans. N. Anderson)
Numerical Methods
Prentice Hall

J. Stoer and R. Bulirsch
Introduction to Numerical Analysis
Springer Verlag

Academic integrity

Assignments, homeworks and exams must be your own individual work and using only course materials. While students at your level are well aware of what academic integrity means, please note that violating academic integrity includes more things than presenting others' work as one's own. For example, *not taking reasonable measures to protect your work from being plagiarized by others is also a violation of academic integrity*. This is becoming particularly important now that so many things are online.

You should *never post anywhere or share with anyone* assignments, exams, questions or solutions, *even after the deadline*.

Additional information

Assignments will be submitted electronically; details to be given with each assessment.

Assignments will be (highly preferably) typed in latex. A template is given in the course website. Other document processors are acceptable, as long as they produce pdf output. If an assignment is *very cleanly* handwritten and scanned *on a proper scanner* as a single pdf file, and *not photographed*, then it is also acceptable. Photographed assignments will receive 0 marks.

Exams will be handwritten and in-person.

Must get at least 30% in **each** of the assessments; can't skip any

For office hours in person, please wear a mask before entering the room. Office hours are for individual students, not groups of students.