CSC336F Numerical Methods Fall 2023

Lecturer : Christina C. Christara (ccc@cs.toronto.edu)
Lectures : Tuesday 18:00-20:00 Room BA 1170
Tutorial : Tuesday 20:00-21:00 Room BA 1170 (tutorial times may be used for lectures)
Office Hours : Tuesday 16:30-17:30 Room BA 4226 (please wear a mask) or
: online (send me a message)
Textbook : Michael Heath, Scientific Computing: an introductory survey, SIAM 2018
available from the SIAM website, cheaper if you become member, see details in course website below
equivalent to same book McGraw-Hill Inc. 2002, custom-copy used in past years
Web site : `http://www.cs.toronto.edu/~ccc/Courses/336.html`
Bulletin board : `https://bb-2023-09.teach.cs.toronto.edu/c/csc336` (after first week)

Aims of course

Introduce numerical methods for solving (linear and nonlinear) equations, and approximation problems.
Evaluate numerical methods with respect to their accuracy, time and memory complexity.
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 high level mathematical software.
Judge the correctness of numerical results and connect them with theory

Prerequisite Mathematics and other

Ability to handle notation and to do algebraic manipulation
Matrix and vector addition and multiplication, elementary row operations, linear (in)dependence
Differentiation and integration of polynomial, trigonometric, exponential, logarithmic and rational functions
Elementary calculus including
Taylor series, Rolle's and mean value theorems, functions graphs, continuity, limits, de l' Hospital's rule, etc.
Induction
Other: knowledge of some programming language, such as MATLAB.

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 (tentative)

Assignment 1	Due Wednesday, October 4, 2023	6 PM	13%
Term test	Tuesday, October 24, 2023	6-7 PM	21%
Assignment 2	Due Wednesday, November 15, 2023	6 PM	13%
Assignment 3	Due Wednesday, December 6, 2023	6 PM	13%
Final exam	2 hours -- date/time TBA		40%

• Must get at least 30% in each of the exams and in **each** of the other assessments; can't skip any
• Must get at least 30% average in the computer part of assignments.
• **Term tests and Final exam**: calculators are the only aids permitted.
• Final exam to be scheduled by the A&S Faculty.

Problem sets / Computer assignments / Exams

problem sets: please write as clearly as possible.
Capitalize or underline your last name 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.
– 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, during class 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 (two) days. Assignments submitted later than 2 days after the due date do not receive any marks. If applicable, weekends and holidays count as regular days for the purpose of late assignment policy.

Topics to be covered

- Computer Arithmetic and Computational Errors (Ch 1) – 6 hours
  - Representation of numbers, machine arithmetic
  - Round-off error, error propagation, conditioning, stability
- Square linear systems of equations (Ch. 2) – 10 hours
  - Gauss elimination, LU factorisation, pivoting, scaling, forward and back substitution
  - Vector & matrix norms
  - Condition numbers for systems
- Nonlinear equations / systems (Ch. 5) – 8 hours
  - Bisection, secant
  - Fixed point iteration, Newton's method
  - Convergence
- Interpolation (Ch. 7) – 7 hours
  - Polynomial interpolation
  - Piecewise polynomial interpolation
  - Spline interpolation

Other references

Conte, S. D. and Carl de Boor
Elementary Numerical Analysis
McGraw-Hill Inc., or SIAM

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

D. Kahaner, C. Moler, S. Nash
Numerical Methods and Software
Prentice Hall

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

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

Hager, William
Applied Numerical Linear Algebra
Prentice Hall

Moler, Cleve
Numerical Computing with MATLAB
Cambridge Univ. Press

The Heath book published by SIAM is equivalent to the custom-made copy used in the past for the same course. This is the same book used for CSC436.

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, when so many things are online.

You should *never post anywhere or share with anyone* assignments (or parts thereof), exams (or parts thereof) or solutions (or parts thereof), *even after the deadline*.

Additional information

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

Assignments will be 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.

Tests/exams will be synchronous and in person.

The final exam will be scheduled by the A&S Faculty.

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

Lecture and tutorial times may be used interchangeably.

Office hours will be available at my office, either at default times posted, or at other mutually agreeable times. If there is need for remote office hours, this is possible with advance notice.
Office hours will be for individual students, not for a group of students. Please wear a mask before coming in; only one student at a time.

Presentation of assignments

General
Include your name and student id in the front page and underline last name. Use font size 12 or larger. Use fixed width fonts (e.g. Courier) for code and output. *Never* use dark background, for anything.

Tables and code output
Always align output with an appropriate format statement. (Align to match equivalent order digits.) Use exponential format for very large (e.g. condition numbers) numbers and very small numbers (e.g. errors, residuals) Use integer format for number of iterations, grid sizes, etc. Always use headers for columns in tables.

Plots
When we say plot quantity A versus B, we mean A is in the vertical (y) axis and B in the horizontal (x). Always use captions for plots/figures, and proper diacritical marks and legends when drawing more than one line.

Submission
Do NOT submit zip, rar and similar files on MarkUs. Only submit pdf, image (eps, png, etc), text (incl. code, latex), etc.

Other
Do not use any symbolic computation, such as symbolic differentiation, etc.