

CS/SE 4X03 SCIENTIFIC COMPUTATION

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DEPARTMENT OF COMPUTING AND SOFTWARE
MCMASTER UNIVERSITY
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Lectures:	Monday, Wednesday, Thursday	1:30PM – 2:20PM	JHE 264
Tutorials:	Tuesday	4:30PM - 5:20PM	ETB 238
	Tuesday	5:30PM - 6:20PM	ETB 238
	Thursday	10:30AM - 11:20AM	BSB 136
Office hours:	Monday	3:30-5:00	ITB 123

Instructor

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Teaching assistants

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1. INTRODUCTION

This is an introductory course to scientific computing. We will study floating-point issues in numerical computing and various numerical algorithms. For example, we will learn about numerical differentiation and integration, solving linear systems, computing eigenvalues, least-squares problems, and will give a brief introduction to continuous optimization and numerical methods for ordinary differential equations.

We shall study error analysis of numerical algorithms, convergence, and stability. In this course, we will use Matlab as a programming language and environment.

The course web page is <http://www.cas.mcmaster.ca/~nedialk/COURSES/4X03>.

2. LEARNING OBJECTIVES

Postcondition. A *learning objective* for a course is something the student is expected to know and understand or to be able to do by the end of the course. The learning objectives for this course are given below. Taken together, this set of learning objectives constitute the *postcondition* of the course.

1. Students should know and understand
 - (a) issues in floating-point (FP) computations, overflow, cancellations, roundoff errors
 - (b) truncation errors
 - (c) solving linear systems
 - (d) linear least squares
 - (e) solving non-linear equations
 - (f) interpolation
 - (g) numerical integration
 - (h) stability of methods for initial-value problems in ordinary differential equations
2. Students should be able to
 - (a) perform roundoff error analysis
 - (b) derive error bounds
 - (c) interpret numerical results
 - (d) perform simple complexity analysis

- (e) analyze convergence
- (f) analyze stability
- (g) write Matlab programs implementing numerical methods

Precondition. The *precondition* of the course is the set of university-level learning objectives that the student is expected to have achieved before the start of the course.

The precondition includes knowledge of

- calculus
- linear algebra

3. TEXT

- Required: Ward Cheney and David Kinkaid, *Numerical Mathematics and Computing*, Brook/Cole Publishing Company.
- Optional: Student Solution Manual

4. TOPICS

- Floating-point arithmetic
- Interpolation and numerical differentiation
- Numerical integration
- Solving systems of linear equations
- Computing eigenvalues
- Least squares
- Solving nonlinear equations
- Introduction to continuous optimization
- Methods for initial value problems for ordinary differential equations

5. READING AND SUGGESTED EXERCISES

These will be updated as we progress with the course.

§X: Y means Section X should be studied and exercise Y is suggested

The corresponding numbers from the 6th edition are given in (\dots).

- Chapter 1
 - §1.1: 8, 10 (§1.1: 8, 10)
 - §1.2: 8, 9, 23, 30, 41 (§1.2: 8, 9, 23, 30, 41)
 - §1.3: 13, 14, 18, 22, 24, 45 (§2.1: 13, 14, 18, 24, 45)
 - §1.4: 8, 11, 13, 14, 24, 26, 29 (§2.2: 8, 11, 14, 24, 26, 29)

Note: skip the theorem on loss of precision
- Chapter 2
 - §2.1: 1, 2, 7a (§7.1: 1, 2, 7a)
 - §2.2: 1, 8, 9, 23 (§7.2: 1, 8, 9, 23)
 - Gauss elimination
 - Pivoting

6. GRADING SCHEME

Assignment 1	10%	21 Jan – 31 Jan
Assignment 2	10%	31 Jan – 13 Feb
Midterm	15%	14 Feb during class time
Assignment 3	10%	4 March – 18 March
Assignment 4	10%	18 March – 1 April
Final exam	45%	

7. RESOURCES

- The Web site for the textbook is <http://www.ma.utexas.edu/CNA/NMC7/index.html>
- In addition to Matlab, you may consider using Octave <http://www.octave.org>.
- Matlab Primer https://www.mathworks.com/help/pdf_doc/matlab/getstart.pdf .
- A Beginner's Guide to Matlab http://homen.vsb.cz/~lud0016/NM/matlab_guide.pdf
- Short introduction to floating-point numbers by Clever Moler https://www.mathworks.com/company/newsletters/news_notes/pdf/Fall196Cleve.pdf
- D. Goldberg. What Every Computer Scientist Should Know About Floating-Point Arithmetic. HTML http://docs.oracle.com/cd/E19957-01/806-3568/ncg_goldberg.html
PDF <http://www.validlab.com/goldberg/paper.pdf>
- W. Kahan, Floating-Point Arithmetic Besieged by "Business Decisions" https://people.eecs.berkeley.edu/~wkahan/ARITH_17.pdf

8. COURSE POLICY

Course-related announcements will be at the course web site. You are responsible for checking it regularly.

Assignments.

- The assignments will be due at the beginning of the lectures.
- A submission after 1:35pm (on the day an assignment is due) is late.
- Late work will not be graded without an MSAF.
- You are allowed to discuss the problems from the assignments. However, you **must submit your own work**.

Please study what academic dishonesty, plagiarism, and inappropriate collaboration mean. See <https://www.mcmaster.ca/academicintegrity/students/index.html>

Midterm/Final.

- During the exams, you are allowed to use one sheet, both sides, containing course material and a calculator.
- The final exam will cover the whole material, not just the material presented after the midterm date.

Missed work.

- The MSAF accommodation for a missed assignment is a 5 day extension from the original assignment deadline. The MSAF accommodation for a missed midterm is to roll the weight of the midterm into the weight of the final examination.

Remarking.

- Requests for remarking of an assignment or a test must be made within one week after the marked assignment/test is returned.
- Requests that are later than a week will not be accommodated.

Changes.

- The instructor reserves the right to modify elements of this course and will notify students accordingly (in class and post any changes to the course website).

9. ACADEMIC DISHONESTY

You are expected to exhibit honesty and use ethical behaviour in all aspects of the learning process. Academic credentials you earn are rooted in principles of honesty and academic integrity.

Academic dishonesty is to knowingly act or fail to act in a way that results or could result in unearned academic credit or advantage. This behaviour can result in serious consequences, e.g. the grade of zero on an assignment, loss of credit with a notation on the transcript (notation reads: Grade of F assigned for academic dishonesty), and/or suspension or expulsion from the university.

It is your responsibility to understand what constitutes academic dishonesty. For information on the various types of academic dishonesty please refer to the Academic Integrity Policy, located at <http://www.mcmaster.ca/academicintegrity>

The following illustrates only three forms of academic dishonesty:

1. Plagiarism, e.g. the submission of work that is not ones own or for which other credit has been obtained.
2. Improper collaboration in group work.
3. Copying or using unauthorized aids in tests and examinations.

10. ACADEMIC ACCOMMODATION OF STUDENTS WITH DISABILITIES

Students who require academic accommodation must contact Student Accessibility Services (SAS) to make arrangements with a Program Coordinator. Academic accommodations must be arranged for each term of study. Student Accessibility Services can be contacted by phone 905-525-9140, ext. 2865 or e-mail sas@mcmaster.ca. For further information, consult McMaster Universitys Policy for [Academic Accommodation of Students with Disabilities](#).

11. FACULTY NOTICES

“The Faculty of Engineering is concerned with ensuring an environment that is free of all discrimination. If there is a problem, individuals are reminded that they should contact the Department Chair, the Sexual Harassment Officer or the Human Rights Consultant, as the problem occurs.”