CS 370 - Fall 2023: Course Outline

Numerical Computation

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- **Course Description**: This course provides an overview of numerical algorithms and they are presented in the context of specific applications to image processing, analysis of data, and scientific modeling. Topics include: visualization of results, approximation by splines, fast Fourier transform, differential equations, numerical linear algebra, floating point number systems, error analysis, and stability.
- **Course Objectives**: Students will study the basic numerical algorithms, software environments, and applications of scientific computing. Students will apply the computational techniques for solving simple and yet realistic practical problems.
- **Tentative schedule (subject to change)**:

September 6	Introduction	
Week of Sept 11	Floating point system, Rounding error analysis Conditioning, Stability	
Week of Sept 18	Polynomial interpolation Spline interpolation	
Week of Sept 25	Computation of splines, Planar parametric curves	
Week of Oct 2	Ordinary differential equations, Euler, Midpoint, Modified Euler, Runge-Kutta methods	Assignment 1 due
Week of Oct 9	Reading Week (no class)	
Week of Oct 16	Local truncation error, Global error, Time step size control	
Week of Oct 23	Stability analysis, Periodic functions, Fourier series	Midterm (Oct 24)
Week of Oct 30	Discrete Fourier transform (DFT), Fourier frequencies and coefficients	Assignment 2 due
Week of Nov 6	Signal and image processing Fast Fourier Transform (FFT)	
Week of Nov 13	Convolution, Correlation Gaussian elimination	Assignment 3 due
Week of Nov 20	LU factorization, Forward/Back solve,	

	Complexity analysis	
Week of Nov 27	Conditioning, Stability, Pivoting, Google PageRank	
Week of Dec 4	Least squares problem	Assignment 4 due

- **Text and References**: The main source of information for the course is the material covered in class lectures. Details of some of the more mathematical material is available in the form of typeset course notes, which are posted on the class homepage on Learn. There are more materials in these notes than we are going to cover in this course. The notes, however, are terse summaries of some of the topics covered in the class lectures.

- **Programming Languages**: Python is used for the programming assignments. There are many resources of Python information on the internet. Some of them are posted on the class homepage.

- **Assignments**: Assignments will be available on Crowdmark approximately two weeks before the due dates. All assignment solutions, including written answers, graphs, tables, results and program listings must be submitted electronically on Crowdmark. In addition, all python code should be submitted in corresponding Learn dropbox. Marks may be deducted for any late or missing python code. All submissions (Crowdmark and Learn dropbox) must be completed by the due dates of the assignments. Marked assignments will be returned on Crowdmark within 2 weeks of the due dates.

  Students are welcome to discuss the assignment solutions with the instructors and TA's after the assignments are returned. Formal complete solutions of the assignments will not be available. However, videos discussing the assignment solutions may be posted online.

- **Late Policy**: Late assignments submitted within 24 hours of the due date will be marked at half credit; i.e. 50% deduction. You may not hand in part of your assignment on time and part late; if this happens, the entire assignment will be marked as late. Assignments submitted more than 24 hours late will not be accepted.

- **Assignment Help**: Students can discuss general concepts and problems with other individuals in class. However, the solution that you submit must be worked through by yourself and written in your own words.

  Piazza is a useful forum for posting assignment questions or questions about the course materials. Students are also encouraged to attend the office hours by the instructors and TAs.

- **Marking**: The assignments will consist of programming problems and analytic work. Most of the marks for the programming problems will be given for the description of the algorithm and explanation of the results or output. Simply submitting "raw code" will get very few marks. The results should be presented clearly in the form of table, graph, etc. You will receive no mark if you present results as comments in the code.

  Assignment figures and graphs should be carefully thought out to present the data and conclusions in an effective and clear manner. Poor presentation of your work will result in a poor mark.

  In all cases, we expect you to explain your methods, and describe what you see in detail. You should also submit your code to Learn dropbox, along with documentation. Python has good plotting functions. Create figures with Python to include in your assignments.

- **Assignment/Midterm Marking Appeals**: If you feel your assignment/midterm was marked incorrectly, write an explanation of what you would like reviewed, attach this to your (marked) assignment/midterm,

and submit this electronically to the course instructors, who will pass this to the appropriate TA. Reviews of assignment/midterm marking must be submitted within one week from the time the assignments/midterm are returned.

- **Midterm**: The midterm exam is scheduled on Tuesday, October 24, 2023, 4:30pm-6:20pm, DC 1351, MC 4020, MC 4040, MC 4042, and MC 4058 (5 rooms).

- **Final exam**: Students are advised not to make any travel arrangements before the final exam times are posted. Note that in the event that the final exam is postponed, the final exam will be rescheduled for the day following the end of the regular exam schedule. Under no circumstances will alternate exams be scheduled for students who have made travel arrangements which conflict with the final exam. Students must inform the Registrar's Office if they have a conflict in the final exam schedule, by the date posted on the Registrar's website. Note that there is a precise definition of conflict as defined by the Registrar's Office. The course instructor will then be contacted by the Registrar's Office to make alternate arrangements. Under no circumstances will the instructor make alternate arrangements for a final exam unless given instructions by the Registrar's Office.

- **Course Grade**: There will be four assignments, a midterm, and a final exam. Each assignment will count 8%, so a total of 32%. The midterm is worth 24%, and the final exam 44%. In order to pass the course, student must have a pass on the exam component. Thus you must obtain a mark of 34 (out of 68) on the total of the midterm and final marks in order to pass the course. If you obtain less than 34 out of 68 on the final examination and midterm marks, your final course grade will be the sum of your midterm and final exam marks.

- **48-Hour Absence**: As of Fall 2022, the University introduced the option for students to declare a 48-hour absence during the Formal Lecture Period for any reason. If an absence happens to overlap with an assignment deadline or the midterm, we offer the following accommodations:

  - Assignments: The assignment will be excused and its weight distributed across the remaining written assignments.
  - Midterm: The weight of the midterm will be shifted to the final exam.

- **Plagiarism**: Plagiarism is representing the work of others as your own. Plagiarism on exams includes using unauthorized aids or communicating in any way with others during an examination. Plagiarism on assignments includes copying another student's solution and submitting it as your own, allowing another student to copy your solution, collaborating excessively with another student, or obtaining solutions from any other source. See the section on Discipline below for typical penalties.

  All academic offenses are reported to the Associate Dean for Undergraduate Studies and are recorded in the student's file. Subsequent academic offenses in the same course or in other courses will lead to more severe penalties, up to and including suspension and expulsion.

  We encourage you to discuss general concepts and problems with classmates, tutors, TAs, and instructors. However, the solution that you submit must be worked through by yourself and written in your own words. It is not acceptable to work on an assignment with somebody else and write it up individually. The only exceptions are assignments or projects which the instructor designates as group activities. When discussing course matters, do not take notes, and do not look at another person's partial solutions, or show them yours.

- **Avoiding Academic Offenses**: Most students are unaware of the line between acceptable and unacceptable academic behaviour, especially when discussing assignments with classmates and using the work of

other students. For information on commonly misunderstood academic offenses and how to avoid them, students should refer to the Faculty of Mathematics Cheating and Student Academic Discipline Policy (http://www.math.uwaterloo.ca/navigation/Current/cheating_policy.shtml).

- **Academic Integrity**: In order to maintain a culture of academic integrity, members of the University of Waterloo community are expected to promote honesty, trust, fairness, respect and responsibility (https://uwaterloo.ca/academic-integrity/).

- **Grievance**: A student who believes that a decision affecting some aspect of his/her university life has been unfair or unreasonable may have grounds for initiating a grievance. Read Policy 70, *Student Petitions and Grievances*, *Section 4* (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-70). When in doubt, please be certain to contact the department's administrative assistant who will provide further assistance.

- **Discipline**: A student is expected to know what constitutes academic integrity to avoid committing academic offenses, and to take responsibility for his/her actions. A student who is unsure whether an action constitutes an offense, or who needs help in learning how to avoid offenses (e.g., plagiarism, cheating) or about "rules" for group work/ collaboration should seek guidance from the course instructor, academic advisor, or the undergraduate Associate Dean. For information on categories of offenses and types of penalties, students should refer to Policy 71, *Student Discipline* (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-71). For typical penalties, check *Guidelines for the Assessment of Penalties* (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/guidelines/guidelines-assessment-penalties).

- **Appeals**: A decision made or penalty imposed under Policy 70, *Student Petitions and Grievances* (other than a petition), or Policy 71, *Student Discipline*, may be appealed if there is a ground. A student who believes he/she has a ground for an appeal should refer to Policy 72, *Student Appeals* (https://uwaterloo.ca/secretariat/policies-procedures-guidelines/policy-72).

- **Note for Students with Disabilities**: The AccessAbility Office is located in Needles Hall, Room 1401, collaborates with all academic departments to arrange appropriate accommodations for students with disabilities without compromising the academic integrity of the curriculum. If you require academic accommodations to lessen the impact of your disability, please register with AccessAbility Services at the beginning of each academic term.

- **Intellectual Property**: Students should be aware that this course contains the intellectual property of their instructor, TA, and/or the University of Waterloo. Intellectual property includes items such as:

  - Lecture content, spoken and written (and any audio/video recording thereof);
  - Lecture handouts, presentations, and other materials prepared for the course (e.g. PowerPoint slides);
  - Questions or solution sets from various types of assessments (e.g. assignments, quizzes, tests, final exams); and
  - Work protected by copyright (e.g. any work authored by the instructor or TA or used by the instructor or TA with permission of the copyright owner).

  Course materials and the intellectual property contained therein, are used to enhance a student's educational experience. However, sharing this intellectual property without the intellectual property owner's permission is a violation of intellectual property rights. For this reason, it is necessary to ask the instructor, TA and/or the University of Waterloo for permission before uploading and sharing the intellectual property of others online (e.g. to an online repository).

Permission from an instructor, TA or the University is also necessary before sharing the intellectual property of others from completed courses with students taking the same/similar courses in subsequent terms/years. In many cases, instructors might be happy to allow distribution of certain materials. However, doing so without expressed permission is considered a violation of intellectual property rights.

Please alert the instructor if you become aware of intellectual property belonging to others (past or present) circulating, either through the student body or online. The intellectual property rights owner deserves to know (and may have already given their consent).

- **Mental Health Support**: The Faculty of Mathematics encourages students to seek out mental health support if needed.

  On-campus Resources:

  - Campus Wellness https://uwaterloo.ca/campus-wellness/
  - Counselling Services: counselling.services@uwaterloo.ca/ 519-888-4567 ext 32655
  - MATES: one-to-one peer support program offered by Waterloo Undergraduate Student Association (WUSA) and Counselling Services: mates@wusa.ca
  - Health Services: located across the creek from the Student Life Centre, 519-888-4096.

  Off-campus Resources:

  - Good2Talk (24/7): Free confidential help line for post-secondary students. Phone: 1-866-925-5454 (Ontario and Nova Scotia only)
  - Here 24/7: Mental Health and Crisis Service Team. Phone: 1-844-437-3247 (Waterloo Region only)
  - OK2BME: set of support services for lesbian, gay, bisexual, transgender or questioning teens. Phone: 519-884-0000 extension 213 (Waterloo Region only)
  - EMPOWER ME: 1-833-628-5589 for Canada/USA; other countries see: http://studentcare.ca/rte/en/IHaveAPlan_WUSA_EmpowerMe_EmpowerMe
    - EMPOWER ME in China: China North 108007142831, China South 108001402851

- **Diversity**: It is our intent that students from all diverse backgrounds and perspectives be well served by this course, and that students' learning needs be addressed both in and out of class. We recognize the immense value of the diversity in identities, perspectives, and contributions that students bring, and the benefit it has on our educational environment. Your suggestions are encouraged and appreciated. Please let us know ways to improve the effectiveness of the course for you personally or for other students or student groups. In particular:

  - We will gladly honour your request to address you by an alternate/preferred name or gender pronoun. Please advise us of this preference early in the term so we may make appropriate changes to our records.
  - We will honour your religious holidays and celebrations. Please inform of us these at the start of the course.
  - We will follow AccessAbility Services guidelines and protocols on how to best support students with different learning needs.