Math 349: Numerical Analysis

1. Course Summary

In a typical mathematics course, a student learns a combination of theory and computation, with the latter providing concrete examples of how the former is exhibited "in the real world." Of course, "the real world" in a mathematics class is the realm of pure mathematics, where real numbers have infinite decimal expansions and there are a continuum of numbers that are as close to zero as you like. In the real world that we experience on a day-to-day basis, however, concepts which rely on infinite precision have a harder time being implemented in a practical way; one simply only has so much memory that one can allocate to storing the decimal digits of π, for instance. The typical answer to this problem is to allow ourselves to approximate real values in our computations, with the tacit assumption that these approximated values will be sufficient for any "real" problem we might face. Moreover, if there's some situation where one needs additional precision when doing a certain computation, the assumption is that if one begins with a higher precision approximation to the number in question, then computations with this better approximation should themselves be more precise.

In many ways, numerical analysis is the class in which one investigates whether these assumptions are true. It is a class that is steeped both in practical application (almost by its nature), but also intimately connected to deeply theoretical — and often philosophical — considerations. Perhaps the most consistent question we will aim to answer in this class is: how can I approximate a particular mathematical computation, and how well do I understand the error in this approximation? In answering this question we'll consider how computers store and process real numbers, how algebraically equivalent expressions for two quantities can yield dramatically different computed results, and how to effectively compress information to retain only the most important information.

2. Course Details

2.1. **Professor.** The professor for this class is Andy Schultz. His office is on the third floor of the Science Center, room S352. His office hours will be Monday from 2-4, Wednesday from 9-10, and Friday from 9:30 to 10:30. You are highly encouraged to attend office hours, and you never need an appointment to do so. If these office hours don't fit with your schedule, contact the instructor so that he can either adjust when "official" office hours are held or set up an appointment to help you outside of office hours.

You can contact the instructor at `andrew.c.schultz@gmail.com`. Though he is always happy to receive emails from you with questions or concerns about the course, he can't guarantee that he'll be able to promptly reply to emails late at night or over the weekend. If you do contact the professor by email, please be sure to follow standard email etiquette. In particular, please make sure you include a greeting and signature and avoid abbreviations. If you're contacting him to ask about a problem, please be sure to specify what the problem asks (as opposed to asking something like "I can't get problem 2 and need your help").

2.2. **Text.** The course is centered around the first edition of Sauer's "Numerical Analysis." Students will be expected to read from the book in preparation for class each day, and they should treat the book as a helpful reference when attempting to digest lectures. It is not essential that you get the first edition of the text, though it's typically much less expensive than the second edition. If you get a copy of the text which differs from the first edition, it will be your responsibility to ensure that you complete the correct problems when homework assignments are drawn from the text.

2.3. **Online resources.** You'll be able to access homework assignments and solutions, lecture summaries and copies of tests online through the course webpage at `http://palmer.wellesley.edu/~aschultz/w13/math349`. There is also a google group for the class that everyone is free to post to; this can be an excellent way to have out-of-class discussions about course material.

3. Expectations

3.1. **Prerequisites.** Students are expected to have completed a course in linear algebra before taking this class. Though not required, it is also helpful if students have had extensive experience in any of the following: mathematical proof, analysis, and introductory programming. This course acts as a kind of applied survey of many mathematical ideas you may have seen, starting with high school algebra (root finding) and then proceeding through calculus (differentiation, integration, series and basic differential equations) and linear algebra (solving linear systems of equations, least squares problems). Our perspective on these problems will be new, but a working knowledge of the theory that dictates these problems is essential.

3.2. **In-class expectations.** A student's engaged presence is expected in classroom lectures. While the professor is in charge of determining what content is covered during a class period, students share the responsibility of directing lectures and discussion sections so each is as clear as possible. In particular, students should feel comfortable stopping the instructor to ask him to repeat a particular exposition, to present a concrete example of an abstract concept, or to explain a confusing concept in a new way. Classroom time is there for the benefit of students, so should be treated as an interactive resource.

3.3. **Attendance.** Mathematics requires that a student understand one concept before moving on to the next, and since our course moves at a fast pace it is critical that you attend class on a regular basis. That said, the instructor won't be formally taking roll in this class. While there is no set penalty for the occasional absence, being absent on the day of an exam will result in a score of 0 on that exam. The only acceptable excuses for missing any assignment or written evaluation are conflicts due to university-related travel, serious personal illness, or family emergency. Notice in particular that minor illnesses are *not excusable.*

3.4. **Effort.** Many students have the impression that "understanding the material" means instantly knowing how to do problems assigned in the class. On the contrary, most students find they don't truly understand the course material until they have struggled through several attempts at solving problems or understanding concepts. You are expected to exert a good amount of effort in working through the course material, and you shouldn't be discouraged if a certain topic remains elusive when you first encounter it: try some suggested problems, go to office hours, and ask your instructor or friends for help when you need it.

As a reminder, this is a 300-level mathematics course, and as such it means we will cover material both rigorously and quickly. It also means that students will sometimes be expected to "connect the dots" between the theory we talk about in class and the problems that are assigned for homework; in other words: not all problems will be facsimiles of problems worked out in class.

3.5. **Academic Integrity.** Students are expected to read and understand the college's Honor Code. Incidents where academic integrity have been compromised will be dealt with severely. Although most students have a good feel for what constitutes a violation of the Honor Code, for this class you will also need to be familiar with the instructor's policy on homework collaboration. Please be sure to thoroughly read and understand the section on homework below to avoid an inadvertent violation of the Honor Code. Additionally, you should be aware that you are not to consult any copies of old homework sets, quizzes or tests from this class that you might somehow have access to. Along those same lines, you should not consult solutions to problems from our text that you might find online, in the library, or anywhere else. If the professor finds out that you are consulting materials from previous versions of this class or from published or online materials related to this text, he will consider it a violation of the Honor Code.

4. Grading

Your performance in this class is graded based on your ability to perform two tasks. First, you are expected to develop an understanding of concepts covered in the course and an ability to do related computations. Second, you are expected to be able to clearly display your understanding to your instructor and your peers. Though these goals are certainly interrelated, a mastery of one skill does not imply a mastery of the other. For instance, it's possible that you have a good understanding of the course material but can't exhibit this to someone else.

4.1. **Homework.** Homework problems will be assigned once per week. Students are to write their solutions neatly and submit them to the envelope on the instructor's door at the allotted time. Each student is given one late pass per semester to accommodate the occasional illness or emergency; late homeworks should be submitted within 5 working days of the original due date.

An important note about collaboration and the Honor Code. Students are more than welcome to work with the instructor or their friends when solving homework problems. In the event that you have taken notes while working with someone else, you must put these notes away and recreate the solutions on your own when you begin writing up your homework assignment. You should also never look at the written solutions of a fellow classmate. If you have any confusion about this policy, please talk to the instructor. Also, many assignments will include problems that are labelled as "starred problems." These are problems that you should complete without consultation with a classmate or peer. You are allowed to discuss these problems with the instructor, but only on a one-on-one basis.

4.2. **Quizzes.** There will be in-class, timed quizzes given in this course, occurring (approximately) every week beginning with the second week of class. Quizzes will last 10-20 minutes. If you need to use a calculator on a quiz, it will be provided for you. Your quiz average will be computed after dropping your lowest quiz score. Barring extreme circumstances, make-up quizzes will not be given. In general, the material covered on quizzes will include recitation of definitions or theorems learned in class and calculations which should be familiar to students who are up-to-date on the homework.

4.3. **Projects.** There will be 2 or 3 projects assigned during the semester that you will complete with a partner. These projects will be a bit more open-ended than a typical homework assignment, and you and your partner will have several weeks to complete your solution. Further details will be provided as the assignments draw closer.

4.4. **Tests.** There will be 2 midterm examinations and 1 final, all of which will be take-home. The first exam will be handed out on Friday, March 8, and the second will be handed out on Friday, April 19. Your final will also be take-home.

4.5. **Computing your grade.** Your grade is computed as follows:

- Midterm 1 ..... 20%
- Midterm 2 ..... 20%
- Quizzes 10%
- Projects 10%
- Homework Average 15%
- Final 25%