MATH 361S SYLLABUS, SPRING 2018

Instructor: Jeffrey Wong
Office: Physics 029-B
Class times: WF 3:05-4:20
Location: Physics 227
Website: Piazza (https://piazza.com/duke/spring2018/math361s/home) and course site at http://services.math.duke.edu/~jtwong/math361/main.html


Course description: Development of numerical techniques for accurate, efficient solution of problems in science, engineering, and mathematics through the use of computers. Linear systems, nonlinear equations, optimization, numerical integration, differential equations, simulation of dynamical systems, error analysis.

Prerequisites: A solid understanding of concepts from linear algebra (at the level of Math 221) is essential, including linearity, solving linear systems, eigenvalues and eigenvectors. A course in multi-variable calculus (Math 212) is also required. Experience with ordinary differential equations is recommended, but not necessary. Some exposure to basic programming is required in some language (e.g. from an introductory course such as CS 101). Matlab will be used for the course (you may also use python), but no prior experience with any language will be assumed.

Schedule: Below is a tentative schedule with expected topics. Chapters/sections refer to the textbook (Kincaid & Cheney).

- Week 1: Floating point arithmetic, Matlab (Chapter 2)
- Week 2-3: Error analysis, solving linear systems (Chapter 4)
- Week 4-5: Solving non-linear equations (Chapter 3)
- Week 6-7: Interpolation (Chapter 6.0-6.4)
- Week 8-9: Continuous approximation (Chapter 6.8-6.13)
- Week 10-12: Differentiation and quadrature (Chapter 7)
- Week 13-14: Solution of ordinary differential equations (Chapter 8.0-8.6)
- Week 15: TBA; Presentations
There is some flexibility in the later topics and level of depth in each section, depending on student interest and time constraints. Some possible topics are:

- Continuous optimization (Chapter 11)
- Discrete optimization (Chapter 10)
- Boundary value problems (Chapter 8.7-8.12)
- Eigenvalue estimation (Chapter 5)

A detailed, week-by-week schedule will be posted on the course website.

**Course Logistics**

**Exams and Grading:** Grades will be assigned based on four components:

- Homework (30%): Regular assignments comprised of two parts: theoretical exercises and computational problems (which involve writing code).

- Midterms (40%): Two closed-notes, closed-book exams in class. **Tentative** dates are listed in the schedule. A formula sheet will be provided.

- Final project (30%): An in-depth exploration of a topic in numerical analysis with two components: a written report and an oral presentation to the class.

- Participation: You are encouraged to discuss the material and to ask/answer questions in class, on the Piazza site, or during office hours. Active participation is not assigned a percentage here but will be taken (positively) into account in determining grades.

- **There is no final exam for the course.**

**Homework:**

- Homework will be assigned weekly and will typically be due the following Wednesday. Consult the schedule for due dates.

- Working and studying in groups is encouraged. However, you should write your own solutions to each problem in your own words.

- **No late homework will be accepted,** barring exceptional circumstances as per Duke policy.

- Solutions should be complete arguments; the process by which you arrive at the solution is far more important than a correct answer. When appropriate (which is often), use complete sentences to develop your arguments. Assertions should be supported by computed data and code when it is needed.
• Make sure that all homework pages are stapled together and the work is organized and clearly readable. Solutions should be in the same order as in the list of assigned problems.

Computational problems:

• Some homework problems will require writing and running code. The official choice of language for this course is Matlab (or Octave), which means that examples/solutions will only be in Matlab. You may, however, write your code in python if you prefer (use the numpy package).

• As with theoretical problems, collaboration is encouraged but the code you submit should be your own, which includes not copy-pasting code from other sources. Avoid looking up code online because it is difficult to un-see it when writing your own.

• Expectations for computational problems are detailed in the Guidelines for computational problems document (on Piazza).

Final project: The final project is a research project exploring a topic in numerical analysis in depth and some key applications. Examples include the discrete cosine transform in two dimensions (used for .jpeg image compression) or calculation of dominant eigenvectors as used in Google’s search algorithm (PageRank). Tentative due dates are listed in the schedule at the course website and exact due dates will be announced at a later time.

• The final project has two components: a written report and a presentation. The report must be written in \texttt{\LaTeX} and will take the form of a scientific article, including an introduction, description of numerical methods, discussion of your results, conclusions, references, and an appendix containing your code.

• The report should be about 15 pages (double spaced) including figures and references, and the presentation should be about 15 minutes in length.

• A list of topics will be provided. You may also choose your own topic, subject to instructor approval. A one page abstract of the topic will be due about halfway through the course.

• A draft of the report and presentation will be due in mid-April. Presentations will occur around the last week of classes; the written report will be due during Finals week.
Ethics:
Students are expected to follow the Duke Community Standard. If a student is found responsible for academic dishonesty through the Office of Student Conduct, the student will receive a score of zero for that assignment. If a student's admitted academic dishonesty is resolved directly through a faculty-student resolution agreement approved by the Office of Student Conduct, the terms of that agreement will dictate the grading response to the assignment at issue.