Math 6610: Analysis of Numerical Methods, I
Introduction and Hello

Department of Mathematics, University of Utah

Fall 2025

This is a PhD qualifying exam course:

- Regular homework assignments ($\sim$weekly)
- A midterm and a final exam
- Exams are closed-book, closed-notes

Expectations/prerequisites:

- Undergraduate linear algebra
- Familiarity with proofs
- Familiarity with (basic) programming

What is this course about?

This is a graduate level course in numerical analysis, intended to build off a similar undergraduate course you may been exposed to before. (But we'll cover things in detail beyond the typical undergraduate level.)

If one wanted to prescribe a theme for this course, there are two major questions we seek to answer:

- How are eigenvalues (numerically) computed?
- How does one build accurate and stable approximations to functions?

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These questions are relatively narrow, but cogent answers to these questions can be provided by exposure to diverse aspects of numerical analysis, and this is essentially what we'll do in this course.

This course is intended to prepare you for the next one in the sequence, 6620, when solutions to ordinary/partial differential equations will be explored.

Some logistics

We'll always meet here (JWB 208) over the semester. I won't record/post lectures videos.

Online portals:

- The "course website"
  `http://www.sci.utah.edu/~akil/math6610`
  This is the primary location I'll post info: lecture slides and homework assignments.
- Canvas (accessible through your CIS portal)
  I'll post private information here, namely grades for your submissions and exams

Office hours: TBA, we'll discuss and finalize these later this week.

Your grade

Your grade in this course has three components:

- 40%: Homework assignments
- 25%: Midterm Exam
- 35%: Final exam

Attendance is not a factor in your grade.

Textbook

There isn't really a textbook for this course. Informally, we'll use the following book:

Lloyd N. Trefethen and David Bau (1997). *Numerical Linear Algebra*. SIAM: Society for Industrial and Applied Mathematics. ISBN: 0-89871-361-7

You should arrange to have a copy of this text.

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However, we'll cover material that's some amalgamation of stuff from additional resources:

Kendall Atkinson (1989). *An Introduction to Numerical Analysis*. New York: Wiley. ISBN: 978-0-471-62489-9

Abner J. Salgado and Steven M. Wise (2022). *Classical Numerical Analysis: A Comprehensive Course*. Cambridge: Cambridge University Press. ISBN: 978-1-108-83770-5. DOI: 10.1017/9781108942607

Endre Süli and David F. Mayers (2003). *An Introduction to Numerical Analysis*. Cambridge: Cambridge University Press. ISBN: 978-0-521-00794-8. DOI: 10.1017/CBO9780511801181

Lloyd N. Trefethen (2012). *Approximation Theory and Approximation Practice*. Philadelphia: Society for Industrial and Applied Mathematics. ISBN: 978-1-61197-239-9

Homework

Assigned approximately weekly. Current plan:

- Due on Wednesdays at 5pm MT
- Submit online through Canvas/Gradescope (hand written and/or typed solutions is fine)
- Problem sets will cover material up through the previous Friday
- First assignment due next Wednesday, Aug 27. Material covered up through this Friday, Aug 22.
- Probably 3-6 problems per assignment, some with multiple parts
- Mostly proof-based, with some computing problems sprinkled in
- I encourage you to work with others. (But submissions must be individual.)

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Grading procedure:

- 50% of grade based on correctness
  I'll randomly select $\sim$2 problems to be graded each week. (You won't know which problems these are before submission.)
- 50% of grade based on completion
  Will be awarded based on demonstrating effort for *all* problems on the assignment.
- All assignments are equally weighted
- Your lowest two homework assignment grades over the semester will be dropped in the computation

Exams

Two exams:

Midterm exam

- Friday, October 3, in-class (just before Fall Break)
- Will cover $\sim$6 homework assignments worth of material.
- Closed-book, closed-notes, no calculator

Final exam

- Monday, December 8, 10:30-12:30 here (JWB 208)
- Is a cumulative exam
- Closed-book, closed-notes, no calculator

Slides and material

The material for this course is an amalgamation from a few sources.

Instead of listing all these sources as required, slides like this will be posted.

- I'll mark on slides during class meetings (to explain something, demonstrate a computation/proof, etc.)
- The course webpage will have pdf's of both the unmarked (clean) slides, and the marked slides.
- (I aim to ensure) slides will have references to appropriate text sections.

An overview of topics

Roughly speaking, this course will follow the anatomy:

- 3 weeks: linear algebra review/exposure
- 1 week: finite precision and numerical stability
- 2 weeks: core factorizations (LU, Cholesky, QR, SVD)
- 2 weeks: eigenvalue algorithms
- 2 weeks: numerical solutions to linear and nonlinear systems, optimization
- 2 weeks: Fourier approximation
- 2 weeks: Polynomial approximation

(Cf syllabus calendar for an even more approximate but more detailed list of topics)

The use of AI/LLM's

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"Why do any of this if AI can do it for me?"

The goal is (and has always been) for you to train to reason, think, plan, and execute an investigation. If there's a "right answer", it's important to identify it, but it's arguably more important to develop independent skills that allow you to reach that answer.

References I

- Atkinson, Kendall (1989). *An Introduction to Numerical Analysis*. New York: Wiley. ISBN: 978-0-471-62489-9.
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