Department of Mathematics, University of Utah

Analysis of Numerical Methods I
Math 6610 Section 001 – Fall 2025
Course Information and Syllabus
Updated July 31, 2025

Instructor: Akil Narayan
Email: akil@sci.utah.edu
Office: WEB 4666 and LCB 116

Office hours: TBA

Class type: In Person

Class time and location: MWF 11:50am-12:40pm JWB 208

Attendance policy: Attendance during lectures is *not* a part of your grade. However, I strongly recommend that you attend the lectures; attendance is an essential ingredient for success in this course.

Course webpage: `http://www.sci.utah.edu/~akil/math6610`. This webpage will contain posted lecture notes and assignments.

Canvas: Graded assignments will be collected on Canvas and grades will also be posted on Canvas.

Course Information: This is a 3-credit course.

Prerequisites: "C" or better in Math 5620.

Course description: Mathematical analysis of numerical methods in linear algebra, interpolation, integration, differentiation, approximation (including least squares, Fourier analysis, and wavelets), initial- and boundary-value problems of ordinary and partial differential equations.

Text: Suggested: *Numerical Linear Algebra*, by Trefethen and Bau
The material from this courses will be compiled from a few different sources. The lecture slides will serve as a comprehensive list of topics discussed in this class. I will attempt to cite appropriate references in the slides that relate to topics covered.

Class meetings: Most meetings of this course will be lecture-style meetings, but I heartily encourage you to participate in class, in particular with questions and related discussions.

Homework: Homework is worth 40% of your cumulative grade. Problem sets will be due approximately weekly, posted and collected on Canvas (through Gradescope). Late homework assignments will generally **not** be accepted without approval from me in advance of the due date. However, your lowest two homework assignment grades over the semester will be dropped. Each homework assignment is worth equal weight and the lowest score for a single homework assignment over the semester will be dropped. You are welcome (and encouraged) to work on the homework assignment in groups, *but each student must submit individual work.*

Midterm exam: The midterm exam is worth 25% of your cumulative grade. The midterm exam will be held during class meeting time, and will be closed-book, closed-notes, and no calculator is allowed.

Final Exam: This course will have a single in-class comprehensive final exam. The final exam will be held on Monday, December 8 from 10:30am-12:30pm in JWB 208, in accordance with

university policy. The final exam, worth 35% of your grade, is closed-book and closed-notes, and no calculators will be allowed.

Grading: In summary, your course grade will be computed as follows.

- Homework 40%
- Midterm exam 25%
- Final exam 35%

Final letter grades will be assigned based on the following scheme:

- 92% - 100% — A
- 90% - 91% — A−
- 88% - 89% — B+
- 82% - 87% — B
- 80% - 81% — B−
- 78% - 79% — C+
- 72% - 77% — C
- 70% - 71% — C−
- 68% - 69% — D+
- 62% - 67% — D
- 60% - 61% — D−
- 0% - 59% — E

Important dates:

Aug 29		Last day to add, drop, audit, and elect CR/NC
Oct 3		**Midterm Exam**
Oct 24		Last day to withdraw from classes
Nov 28		Last day to reverse CR/NC option
Dec 5		Reading Day
Dec 8	**10:30am**	Final exam

Learning objectives: This is a PhD qualifier course that covers some of the essentials of numerical anslysis, focusing specifically on (numerical) linear algebra and (numerical) approximation. Students will gain core competencies in numerical and computational basics that can serve as a foundational set of skills for tackling mathematical research. We will focus on the following topics:

- Applied linear algebra: spectrum and singular values, norms, field of values, variational characterizations and low-rank approximations
- Matrix factorizations: LU, Cholesky, QR, SVD
- Computation of eigenvalues: power/Rayleigh iteration, QR algorithm with shifts
- Solutions of linear and nonlinear systems: iterative methods,
- Numerical optimization: descent algorithms, Newton and quasi-Newton approaches
- Fourier approximation: series and expansions, quadrature, FFT, error estimates
- Polynomial approximation: integration, quadrature, interpolation, perhaps orthogonal polynomials

Class communication: I will use the email list provided by University information services to communicate information. This email list will also be used to communicate class information in the case of unusual circumstances affecting the the logistics of the class. If you are not officially registered for the class but wish to be on the roster, please discuss it with me. Some email communications will also be duplicated as announcements on Canvas.

If you are registered for the course, but do not receive the course email announcements to your University of Utah email address, please notify me immediately.

In the event of a major campus emergency, course requirements, deadlines and grading percentages are subject to change that may be necessitated by a revised semester calendar or other circumstances. The above two methods (email and Canvas), in addition to the coursewide website, are reliable means of getting information about changes to the course.

Communication with the instructor: The most reliable and preferred means of contacting me is via email, and I typically respond in less than 24 hours. Communication through the messaging system in Canvas will also work, but possibly with a slightly longer response time.

University-wide policies

Americans With Disabilities Act (ADA) The University of Utah seeks to provide equal access to its programs, services, and activities for people with disabilities.
All written information in this course can be made available in an alternative format with prior notification to the Center for Disability & Access (CDA), `https://disability.utah.edu/`. CDA will work with you and the instructor to make arrangements for accommodations. Prior notice is appreciated. To read the full accommodations policy for the University of Utah, please see Section Q of the Instruction & Evaluation regulations `http://regulations.utah.edu/academics/6-100.php`.
In compliance with ADA requirements, some students may need to record course content. Any recordings of course content are for personal use only, should not be shared, and should never be made publicly available. In addition, recordings must be destroyed at the conclusion of the course.
If you will need accommodations in this class, or for more information about what support they provide, contact:

Center for Disability & Access
801-581-5020
`disability.utah.edu` 162 Union Building 1
200 S. Central Campus Dr.
Salt Lake City, UT 84112

Safety at the U: The University of Utah values the safety of all campus community members. You will receive important emergency alerts and safety messages regarding campus safety via text message. For more safety information and to view available training resources, including helpful videos, visit `safeu.utah.edu`.
To report suspicious activity or to request a courtesy escort, contact:

Campus Police & Department of Public Safety
801-585-COPS (801-585-2677)
`dps.utah.edu`
1735 E. S. Campus Dr.
Salt Lake City, UT 84112

Addressing Sexual Misconduct: Title IX makes it clear that violence and harassment based on sex and gender (which includes sexual orientation and gender identity/expression) is a civil rights offense subject to the same kinds of accountability and the same kinds of support applied

to offenses against other protected categories such as race, national origin, color, religion, age, status as a person with a disability, veteran's status, or genetic information.
If you or someone you know has been harassed or assaulted, you are encouraged to report it to university officials:

Title IX Coordinator & Office of Equal Opportunity and Affirmative Action
801-581-8365
oeo.utah.edu
135 Park Building
201 Presidents' Cir.
Salt Lake City, UT 84112

Office of the Dean of Students
801-581-7066
deanofstudents.utah.edu
270 Union Building
200 S. Central Campus Dr.
Salt Lake City, UT 84112

To file a police report, contact:

Campus Police & Department of Public Safety
801-585-COPS (801-585-2677)
dps.utah.edu
1735 E. S. Campus Dr.
Salt Lake City, UT 84112

If you do not feel comfortable reporting to authorities, the U's Victim-Survivor Advocates provide free, confidential, and trauma-informed support services to students, faculty, and staff who have experienced interpersonal violence.

To privately explore options and resources available to you with an advocate, contact:

Center for Campus Wellness
801-581-7776
wellness.utah.edu
328 Student Services Building
201 S. 1460 E.
Salt Lake City, UT 84112

Academic Misconduct It is expected that students comply with University of Utah policies regarding academic honesty, including but not limited to refraining from cheating, plagiarizing, misrepresenting one's work, and/or inappropriately collaborating. This includes the use of generative artificial intelligence (AI) tools without citation, documentation, or authorization. Students are expected to adhere to the prescribed professional and ethical standards of the profession/discipline for which they are preparing. Any student who engages in academic dishonesty or who violates the professional and ethical standards for their profession/discipline may be subject to academic sanctions as per the University of Utah's Student Code: Policy 6-410: Student Academic Performance, Academic Conduct, and Professional and Ethical Conduct, https://regulations.utah.edu/academics/6-410.php.
Plagiarism and cheating are serious offenses and may be punished by failure on an individual assignment, and/or failure in the course. Academic misconduct, according to the University of Utah Student Code:

"...Includes, but is not limited to, cheating, misrepresenting one's work, inappropriately

collaborating, plagiarism, and fabrication or falsification of information... It also includes facilitating academic misconduct by intentionally helping or attempting to help another to commit an act of academic misconduct."

For details on plagiarism and other important course conduct issues, see the U's Code of Student Rights and Responsibilities, `http://regulations.utah.edu/academics/6-400.php`.

Office of the Dean of Students: The Office of the Dean of Students is dedicated to being a resource to students through support, advocacy, involvement, and accountability. It serves as a support for students facing challenges to their success as students, and assists with the interpretation of University policy and regulations. To contact the Office of the Dean of Students, please email `deanofstudents@utah.edu` or call 801-581-7066. There is more information at `https://deanofstudents.utah.edu`.

Basic Needs Student Support Statement: Success at The University of Utah includes learning about and using available resources. The Basic Needs Collective (BNC) is a coordinated resource referral hub. They educate about and connect students to campus and community resources to help them meet their basic needs. As a central location for resource referrals related to food, housing, health insurance, managing finances, legal services, mental health, etc., any student experiencing difficulty with basic needs is encouraged to contact them. Drop into their office located in the Union basement or schedule with them online for an in-person or virtual visit through their webpage: `https://basicneeds.utah.edu/`.

Community: It is my intent that students from all backgrounds and perspectives be well served by this course, that students' learning needs be addressed both in and out of class, and that the community of students in this class be viewed as a resource, strength, and benefit. It is my intent to present materials and activities that are respectful to all. Your suggestions are encouraged and appreciated. Please let me know ways to improve the effectiveness of the course for you personally or for other students or student groups.

Discrimination and Harassment: If you or someone you know has been harassed or assaulted, you are encouraged to report it to the Title IX Coordinator in the Office of Equal Opportunity and Affirmative Action, 135 Park Building, 801-581-8365, or Office of the Dean of Students, 270 Union Building, 801-581-7066. To report to the police, contact the Department of Public Safety, 801-585-2677(COPS). Please see Student Bill of Rights, section E `http://regulations.utah.edu/academics/6-400.php`. I will listen and believe you if someone is threatening you.

Classroom Social Interactions: Canvas allows students to change the name that is displayed. Class rosters are provided to the instructor with the student's legal name as well as "Preferred first name" (if previously entered by you in the Student Profile section of your CIS account, which can be managed at any time). While CIS refers to this as merely a preference, I will honor you by referring to you with the name that feels best for you in class or on assignments. Please advise me of any name changes so I can help create a learning environment in which you are respected. If you need any assistance or support, please reach out to the Center for Student Access and Resources: `https://studentresources.utah.edu`

English Language Learners: If you are an English language learner, please be aware of several resources on campus that will support you with your language and writing development. These resources include: the Writing Center (`http://writingcenter.utah.edu/`); the Writing Program (`http://writing-program.utah.edu/`); the English Language Institute (`http://continue.utah.edu/eli/`). Please let me know if there is any additional support you would like to discuss for this class.

Immigrant Student Support: Immigration is a complex phenomenon with broad impact—those who are directly affected by it, as well as those who are indirectly affected by their relationships with family members, friends, and loved ones. If your immigration status presents obstacles to engaging in specific activities or fulfilling specific course criteria, confidential arrangements may be requested from the Dream Center. Arrangements with the Dream Center will not jeopardize your student status, your financial aid, or any other part of your residence. The Dream Center offers a wide range of resources to support undocumented students as well as students from mixed-status families. To learn more, please contact the Dream Center at 801-213-3697 or visit `dream.utah.edu`.

Veterans: If you are a student veteran, the University of Utah has a Veterans Support Center located in Room 161 in the Olpin Union Building. Hours: M-F 8-5pm.Please visit their website for more information about what support they offer, a list of ongoing events and links to outside resources: `http://veteranscenter.utah.edu/`.

Semester calendar

(Subject to change!)

Day	Date	Topic
Monday	August 18, 2025	Hello
Wednesday	August 20, 2025	Linear algebra review
Friday	August 22, 2025	Linear algebra review
Monday	August 25, 2025	Orthogonal, projection, permutation matrices
Wednesday	August 27, 2025	Eigenvalues
Friday	August 29, 2025	Eigenvalues
Monday	September 1, 2025	No class: Labor Day
Wednesday	September 3, 2025	Eigenvalues
Friday	September 5, 2025	Normal matrices
Monday	September 8, 2025	The SVD
Wednesday	September 10, 2025	The SVD
Friday	September 12, 2025	Low-rank approximation
Monday	September 15, 2025	Derivatives of trigonometric functions
Wednesday	September 17, 2025	Finite-precision arithmetic
Friday	September 19, 2025	Conditioning and sensitivity
Monday	September 22, 2025	Numerical stability
Wednesday	September 24, 2025	Guassian elimination (LU)
Friday	September 26, 2025	Gaussian elimination (LU)
Monday	September 29, 2025	The Cholesky decomposition
Wednesday	October 1, 2025	Review
Friday	October 3, 2025	**Midterm exam**
Monday	October 6, 2025	No class: Fall Break
Wednesday	October 8, 2025	No class: Fall Break
Friday	October 10, 2025	No class: Fall Break
Monday	October 13, 2025	The QR decomposition
Wednesday	October 15, 2025	Least squares and orthogonal triangularization
Friday	October 17, 2025	Power, inverse, Rayleign iteration
Monday	October 20, 2025	Power, inverse, Rayleigh iteration
Wednesday	October 22, 2025	Power, inverse, Rayleigh iteration
Friday	October 24, 2025	The QR algorithm
Monday	October 27, 2025	The QR algorithm with shifts
Wednesday	October 29, 2025	The QR algorithm with shifts
Friday	October 31, 2025	Iterative methods for linear systems
Monday	November 3, 2025	Krylov subspace methods
Wednesday	November 5, 2025	Krylov subspace methods
Friday	November 7, 2025	Nonlinear systems
Monday	November 10, 2025	Nonlinear systems
Wednesday	November 12, 2025	Numerical optimization
Friday	November 14, 2025	Numerical optimization
Monday	November 17, 2025	Fourier Series, I
Wednesday	November 19, 2025	Fourier Series, II
Friday	November 21, 2025	Fourier Series approximation
Monday	November 24, 2025	Fourier Series approximation
Wednesday	November 26, 2025	Polynomial approximation
Friday	November 28, 2025	No class: Thanksgiving break
Monday	December 1, 2025	Polynomial approximation
Wednesday	December 3, 2025	Polynomial approximation
Friday	December 5, 2025	Polynomial approximation
Monday	December 8, 2025	**Final Exam: 10:30am-12:30pm**