

MATH 437 Principles of Numerical Analysis

Fall 2025 — Section 500

Lecture: TR 3:55pm – 5:10pm, Blocker 121
Recitation: W 12:40am – 1:30pm, Blocker 161
Lecturer: Dr. Matthias Maier
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Office: Blocker 502C
Office hours: TR 2:30pm - 3:30pm, or by appointment
Canvas: <https://canvas.tamu.edu/courses/403398>
Prerequisites: MATH 304, MATH 309, MATH 311, or MATH 323; MATH 308; MATH 409; ability to program; junior or senior classification.
Recitation: Jordan Hoffart,
<https://jordanhoffart.github.io/>
Textbook: *Numerical Analysis*, L. R. Scott
Princeton University Press, 2011

Catalogue Description: Mathematical principles of numerical analysis and their application to the study of particular methods; fixed-point iteration, Newton's method; normed vector spaces and operators, Schur decomposition, convergent matrices, minimization methods, conjugate gradient method; polynomial interpolation of Lagrange and Hermite; best approximation, Bernstein and Weierstrass Theorems, numerical quadrature.

Course overview and learning outcomes:

- In this class, you will learn the basic concepts and some elementary methods in numerical analysis. We will discuss iterative methods to compute roots of nonlinear equations and linear systems of equations and study their convergence. Then, we will learn how to approximate functions by polynomials and to estimate the approximation error.
- The homework will include small programming exercises to gain practical experience using the methods.

Course assessment:

- Two midterm exams, to be held on **Thu Oct 2**, and **Thu Nov 6** (during class).
- The final exam is scheduled for **Mon Dec 15, 1:00-3:00pm**.
- There will be 12 homework assignments *due at the beginning of class* on Tuesday **Sept 2, 9, 16, 23, Oct 7, 21, 28, Nov 11, 18, Dec 2**. The lowest homework score will be dropped.

Tentative schedule:

- Fixed-point iterations (existence + convergence for contractions)
- The Newton-method, quadratic convergence, other methods
- Linear system, Gaussian elimination, LU Factorization
- Proof of LU factorization, The ring of lower triangular matrices
- Cholesky decomposition
- Cholesky decomposition and algorithmic complexity
- Vector spaces, normed spaces, p-norm,
- Norm equivalence, inner-product spaces
- Orthogonal projection and least squares
- The QR decomposition
- The Lagrange interpolating polynomial, interpolation error estimate
- Interpolation error estimate
- Chebyshev interpolation
- Numerical quadrature, interpolatory quadrature
- Summed (composite) quadrature rules
- Gaussian quadrature
- Numerical solution of ODEs: IVPs, Picard & Lindelöf and one-step methods
- Forward & backward Euler, trapezoidal rule
- Explicit Runge-Kutta methods,
- Convergence of one-step methods
- The Lorenz system

Exams and make-up policy: One sheet of handwritten notes (one-sided letter page) can be brought to each exam. Calculators may be needed. Make-ups for exams will only be given if you can provide a documented University-approved excuse. According to *University Student Rules* you are required to notify the instructor in a timely manner in writing when you miss an exam - ideally at least a day in advance. Otherwise you forfeit your right to a make-up. See <https://student-rules.tamu.edu/rule07> for the full university policy.

Assignment and late return policy: Homework and practical assignments are due on Tuesdays 3:55pm before class. Late returns will be accepted up to 48.0 hours past the assignment due date and must be handed in on Thursdays (before class). All late returns will carry a 10% point deduction. Late returns of more than 48.0 hours will receive no points. Exceptions can be made for very good reasons but have to be approved by the instructor (not TA) in advance.

Grading: The final grade will be determined from the following weightings: homework (30 %), midterms (20 % + 20 %), final exam (30 %). Earning 90 %, 80 %, 70 %, or 60 % of the total points will result in a final letter grade of A, B, C, or D, respectively, though, the boundaries between grades may be relaxed (in your favor) at the lecturer's discretion.

◦ ◦ **University Policies** ◦ ◦

*This section outlines the university level policies.
The TAMU Faculty Senate established the wording of these policies.*

Attendance Policy: The university views class attendance and participation as an individual student responsibility. Students are expected to attend class and to complete all assignments. Please refer to Student Rule 7 in its entirety for information about excused absences, including definitions, and related documentation and timelines.

Makeup Work Policy: Students will be excused from attending class on the day of a graded activity or when attendance contributes to a student's grade, for the reasons stated in Student Rule 7, or other reason deemed appropriate by the instructor. Please refer to Student Rule 7 in its entirety for information about makeup work, including definitions, and related documentation and timelines. Absences related to Title IX of the Education Amendments of 1972 may necessitate a period of more than 30 days for make-up work, and the timeframe for make-up work should be agreed upon by the student and instructor (Student Rule 7, Section 7.4.1). The instructor is under no obligation to provide an opportunity for the student to make up work missed because of an unexcused absence (Student Rule 7, Section 7.4.2). Students who request an excused absence are expected to uphold the Aggie Honor Code and Student Conduct Code. (See Student Rule 24).

Academic Integrity Statement and Policy: *"An Aggie does not lie, cheat or steal, or tolerate those who do."* Texas A&M University students are responsible for authenticating all work submitted to an instructor. If asked, students must be able to produce proof that the item submitted is indeed the work of that student. Students must keep appropriate records at all times. The inability to authenticate one's work, should the instructor request it, may be sufficient grounds to initiate an academic misconduct case" (Section 20.1.2.3, Student Rule 20). You can learn more about the Aggie Honor System Office Rules and Procedures, academic integrity, and your rights and responsibilities at <https://aggiehonor.tamu.edu>.

Americans with Disabilities Act (ADA) Policy Statement: Texas A&M University is committed to providing equitable access to learning opportunities for all students. If you experience barriers to your education due to a disability or think you may have a disability, please contact Disability Resources in the Student Services Building or at (979) 845-1637 or visit <https://disability.tamu.edu>. Disabilities may include, but are not limited to attentional, learning, mental health, sensory, physical, or chronic health conditions. All students are encouraged to discuss their disability related needs with Disability Resources and their instructors as soon as possible.

Title IX and Statement on Limits to Confidentiality: Texas A&M University is committed to fostering a learning environment that is safe and productive for all. University policies and federal and state laws prohibit gender-based discrimination and sexual harassment, including sexual assault, sexual exploitation, domestic violence, dating violence, and stalking. With the exception of some medical and mental health providers, all university employees (including full and part-time faculty, staff, paid graduate assistants, student workers, etc.) are Mandatory Reporters and must report to the Title IX Office if the employee experiences, observes, or becomes aware of an incident that meets the following conditions (see University Rule 08.01.01.M1): (i) The incident is reasonably believed to be discrimination or harassment. (ii) The incident

is alleged to have been committed by or against a person who, at the time of the incident, was (1) a student enrolled at the University or (2) an employee of the University.

Mandatory Reporters must file a report regardless of how the information comes to their attention – including but not limited to face-to-face conversations, a written class assignment or paper, class discussion, email, text, or social media post. Although Mandatory Reporters must file a report, in most instances, a person who is subjected to the alleged conduct will be able to control how the report is handled, including whether or not to pursue a formal investigation. The University’s goal is to make sure you are aware of the range of options available to you and to ensure access to the resources you need.

Students wishing to discuss concerns in a confidential setting are encouraged to make an appointment with Counseling and Psychological Services (CAPS). Students can learn more about filing a report, accessing supportive resources, and navigating the Title IX investigation and resolution process on the University’s Title IX webpage, <https://titleix.tamu.edu/>.

Statement on Mental Health and Wellness: Texas A&M University recognizes that mental health and wellness are critical factors that influence a student’s academic success and overall wellbeing. Students are encouraged to engage in proper self-care by utilizing the resources and services available from Counseling & Psychological Services (CAPS). Students who need someone to talk to can call the TAMU Helpline (979-845-2700) from 4:00 p.m. to 8:00 a.m. weekdays and 24 hours on weekends. 24-hour emergency help is also available through the National Suicide Prevention Hotline (800-273-8255) or at suicidepreventionlifeline.org.