MAT 425: NUMERICAL ANALYSIS II
COURSE SYLLABUS

ARIZONA STATE UNIVERSITY
SCHOOL OF MATHEMATICAL AND STATISTICAL SCIENCES

Course Information

Instructor:	Jimmie Adriazola
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Office:	GWC 651, Tempe Campus
Office Hours:	Tuesdays 1-2PM, Wednesdays 10:30-11:30AM or by appointment
Meeting Time:	Tuesday/Thursday, 10:30 AM–11:45 AM
Location:	Tempe Campus, Discovery Hall (DISCOVRY 113)
Course Website:	Canvas (canvas.asu.edu)

Catalog Description

Analysis and implementation of numerical methods for continuous problems arising in science and engineering. Topics include a brief recap/tour of fixed point methods, approximation theory, and numerical quadrature. The remainder of the course will be focused on numerical methods for ordinary differential equations, stability and convergence analysis, and finite difference methods for partial differential equations. Emphasis is placed on error analysis, structure, and the mathematical foundations of numerical algorithms.

Prerequisites

A grade of C or better in MAT 275. MAT 371 (advanced calculus or equivalent), and prior exposure to basic linear algebra and partial differential equations is highly recommended. Students are expected to be comfortable with calculus, elementary proofs, and basic programming in MATLAB or Python.

Textbook and Materials

There is no required textbook for the course. The following texts are recommended references and will be cited throughout the semester.

Numerical Analysis, Timothy Sauer

Introduction to Computation and Modeling for Differential Equations, Lennart Edsberg

Finite Difference Methods for Ordinary and Partial Differential Equations, Randall J. LeVeque

Lecture notes will be provided. Assignments may be completed in either MATLAB, Python, or Julia unless otherwise specified.

Course Learning Outcomes

By the end of this course, students will be able to:

(1) Analyze numerical methods for nonlinear equations, ordinary differential equations, and partial differential equations, with attention to consistency, stability, and convergence.
(2) Derive and assess finite difference discretizations for initial- and boundary-value problems, including error estimates and stability restrictions.
(3) Explain and apply stability concepts, such as absolute stability and Courant-Friedrichs-Levy-type conditions, to determine appropriate numerical methods and time step constraints.
(4) Understand structural properties of discrete operators, including symmetry, positive definiteness, and conditioning, and explain how these properties influence numerical behavior.
(5) Implement numerical methods for ODEs and PDEs and critically interpret computational results, including failure modes and sources of error.
(6) Communicate numerical reasoning clearly and precisely, both analytically and computationally, using appropriate mathematical notation and supporting numerical evidence.

Tentative Course Outline

Week	Topic	Notes
1	Fixed Point Iteration	Calculus Review, Newton's method, Convergence rates
2	Polynomial interpolation	Interpolation error, Runge phenomenon, Chebyshev Points
3	Quadrature	Newton-Cotes, Gaussian Quadrature, Romberg integration
4	Numerical ODE I	Explicit and Implict Euler, local and global error, stability
5	Numerical ODE II	Runge-Kutta methods and Multi-step methods
6	Numerical ODE III	Multi-step methods continued, symplectic integrators
		Exam I covering Weeks 1-4 (in class)
7	Numerical ODE IV	Shooting methods and finite differences for BVPs
8	Parabolic equations I	Intro to PDEs, the method of lines, von Neumann analysis
9	Parabolic equations II	Crank–Nicolson and IMEX methods
10	Elliptic equations I	Finite-differences for the 2D Poisson problem, error analysis
11	Elliptic equations II	Symmetric positive-definite structure, iterative solvers
		Exam II covering Weeks 5-9 (in class)
12	Elliptic equations III	Conditioning ideas, Galerkin methods
13	Hyperbolic equations I	Upwind schemes, Lax-Friedrichs, Lax-Wendroff
14	Hyperbolic equations II	Conservation laws, Riemann problems, and shock-capturing

Assessment and Grading

Homework will consist of about ten assignments that combine analytical and computational components. The two exams are in class and emphasize mathematical structure, stability, and convergence. The final project is a computational investigation of numerical methods for ordinary or partial differential equations. Attendance is expected and will impact your grade.

Homework	**20%**
Exam I	**25%**
Exam II	**25%**
Final Project	**20%**
Class Participation	**10%**

Grading Scale

Final letter grades will be assigned using the following scale.

A+	95–100	B-	73–76
A	90–94	C+	68–72
A-	85–89	C	62–67
B+	81–84	D	56–64
B	77–80	E	below 56

Homework Policy

Homework assignments are due at the beginning of class on the posted due date. Late homework will not be accepted except in documented circumstances or by prior arrangement with the instructor.

Students are encouraged to discuss homework problems with one another at the level of ideas and strategy. However, all submitted work, including written solutions and code, must be completed independently and reflect the student's own understanding.

Expected Classroom Behavior

To maintain a productive and focused learning environment, the following policies will be observed:

- Recording of class content is not permitted.
- Cell phones and other personal electronic devices should not be used during class time, except in extenuating circumstances.
- Small snacks are permitted, but please refrain from eating large meals during class, as this may be disruptive.

Students are expected to attend class regularly and engage respectfully with course material and with one another.

Missed Classes and University-Sanctioned Activities

Please contact the instructor as soon as possible in the event of illness or other circumstances that interfere with attending class or completing course work so that an appropriate plan can be arranged.

Students who participate in university-sanctioned activities that require absence from class will be given the opportunity to make up missed examinations or in-class work. Normally, make-up work will be due on the class day immediately following the absence. Absence due to university-sanctioned activities does not relieve students of responsibility for course material covered during that period.

Academic Integrity

Academic honesty is expected of all students. Homework solutions, code, exams, and project work must represent the student's own understanding. Cheating, plagiarism, fabrication of results, inappropriate collaboration, or misrepresentation of another's work are violations of ASU Academic Integrity policies and may result in academic penalties, including course failure.

Students are responsible for understanding and complying with the ASU Academic Integrity Policy. Additional information can be found on the ASU Provost's website.

Accessibility and Support

Students who anticipate the need for disability accommodations should contact the Student Accessibility and Inclusive Learning Services (SAILS) office as early as possible and notify the instructor so that appropriate arrangements can be made. Accommodations are most effective when arranged early in the semester.

Disruptive or Threatening Behavior

Students are expected to conduct themselves in a manner that promotes a safe and respectful learning environment. Disruptive, threatening, or violent behavior will be addressed in accordance with university policy and may be reported to the appropriate university offices.

Final Note

This syllabus is intended as a guide and may be adjusted as needed during the semester. Any changes will be announced in class and posted on Canvas.