MATH 5485: Introduction to Numerical Methods I Syllabus

Solution of nonlinear equations in one variable. Interpolation, polynomial approximation. Methods for solving linear systems, eigenvalue problems, systems of nonlinear equations.

Fall 2025

Meeting times: 9:05AM–11AM MW, Keller Hall 3-125

Number of credits: 4

Canvas page: https://canvas.umn.edu/courses/519209

Instructor: Jack Thomas

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TA: TBC, TBC@umn.edu

1 Summary

First part of a two-semester sequence that explores the design and implementation of numerical methods to solve the most common types of problems arising in science and engineering. Typically these problems cannot be solved in terms of a classical analytical formula, and thus numerical methods must be used to approximate the solution. Topics include: how a computer does arithmetic, solving nonlinear equations in one variable, polynomial interpolation and approximation, methods for solving linear systems, and matrix eigenvalue problems. We study how and why numerical methods work, and also their errors and limitations.

In MATH 5486, we will study numerical integration and differentiation, solving initial and boundary value ODEs, and (time permitting) PDEs.

1.1 Prerequisites

MATH [2243 or 2373 or 2573]. This course assumes knowledge of calculus, linear algebra, and differential equations, and familiarity with some programming language.

1.2 Goals and Objectives

- Gain familiarity with numerical methods for approximating solutions to common problems arising in science,
- Be able to explain when and why certain methods do (or do not) work,
- Justify your explanations with rigorous error analysis,
- Test your understanding by implementing numerical methods and completing Jupyter notebooks.

1.3 Format

Two lectures per week (9:05AM–11AM MW) (see §4). Combination of slides, blackboard, and Jupyter notebooks.

- Canvas: lecture content will be uploaded to canvas https://canvas.umn.edu/courses/519209
- ChimeIn: for in-class polls use the following link to join https://chimein2.cla.umn.edu/join/838233 (or https://chimein2.cla.umn.edu and use code 838-233)

1.4 Textbooks

We will use the following texts as well as written up lecture notes, interactive notebooks, and (parts of) research articles:

- R. L. Burden, D. J. Faires, and A. M. Burden, *Numerical Analysis, 10th Edition*, Cengage, 2016
- E. Süli and D. Mayers, *An Introduction to Numerical Analysis*, Cambridge University Press, 2003

Other books which may be useful for parts of the course:

- T. A. Driscoll and R. J. Braun, *Fundamentals of Numerical Computation*. Available online https://fncbook.com/
- L. N. Trefethen, *Approximation Theory and Approximation Practice*,

Additional references will be provided on Canvas.

2 Course Grading

The course will be graded by a combination of midterm (on the content of the first 7 weeks), final exam (on the content of the whole course), assignments (Juptyer notebooks), and in-class quizzes.

2.1 Exams

- Midterm: Oct 22, 2025
- Final: TBC

2.2 Grading

The course grade is determined by the following components:

- Midterm 20%
- Assignments and Quizzes 40%

A Final Exam 40%, or

B Final Exam 30%, Presentation 10%

You will be given the opportunity to give a short presentation in the second half of the semester. If your final exam score is higher than the score for your presentation, your final exam will be worth 40% and your presentation will be worth 0% (we will take the maximum of A and B, as above).

There will be at most 10 assignments: most will be short and you will have ten days to complete them.

3 Course Policies

Attendance in class is mandatory. If you cannot attend the class for any reason, please let me know.

Assignments are due on Wednesdays at 5PM. Assignments must be uploaded to Canvas by the deadline. Late assignments will not be accepted and score 0, though the application for an extension can be considered at most twice under reasonable circumstances, and you must send an email to me (cc TA) as early as possible. If you get an extension, the assignment will be due on the following Monday at 9AM (so that we may go through answers in class).

I encourage you to discuss the course material and assignment questions with your classmates. However, unless otherwise explicitly stated on the assignment, you must complete and write up your solutions on your own.

There is no make-up for the midterm exam: if you are absent with good reason, the corresponding proportion can be added to the final exam instead.

If accommodation for exams in the DRC center is needed, you have to send the accommodation letter to me as soon as possible (at least one week in advance).

3.1 Generative AI

The Board of Regents Student Conduct Code states the following in Section IV, Subd.1: Scholastic Dishonesty:

> *"Scholastic dishonesty means plagiarism; cheating on assignments or examinations, including the unauthorized use of online learning support and testing platforms; engaging in unauthorized collaboration on academic work, including the posting of student-generated coursework on online learning support and testing platforms not approved for the specific course in question; taking, acquiring, or using course materials without faculty permission, including the posting of faculty-provided course materials on online learning and testing platforms; ..."*

Generative AI systems and online assignment help tools are online learning support platforms, which **cannot** be used for course assignments. We are testing your knowledge and understanding, not your ability to use GenAI.

The use of online learning support platforms are forms of scholastic dishonesty and will be treated as such.

4 Course Schedule

Here is the planned course schedule (which is subject to change): Assignments will be made available on Mondays and due the following Wednesday.

	Date	**Topic**	**Assignments**
1	3 Sept	Ch0: Introduction to "Introduction to Numerical Methods" and remembering some prerequisites (no class on Sept 1)	A1: Setting up Jupyter notebooks
2	8 Sept 10 Sept	Ch1: How does a computer add? and the basic language of Numerical Analysis	A2: Investigating the rate of convergence of various simple algorithms
3	15 Sept 17 Sept	Ch2: Solving nonlinear equations in 1d: Iteration, Brouwer's fixed point theorem, relaxation, Newton's method	A3: Bisection method
4	22 Sept 24 Sept	Ch2: Solving nonlinear equations in 1d II: divided differences, secant method, (*regula falsi* method), methods with memory,	A4: Geometric interpretation of iterative methods
5	29 Sept 1 Oct	Ch3: Polynomial Interpolation I: Lagrange polynomials, error estimates,	A5: Runge phenomenon
6	6 Oct 8 Oct	Ch3: Polynomial Interpolation II: divided differences, Hermite polynomials,	
7	13 Oct 15 Oct	Ch4: Numerical Integration I: Newton–Cotes (rectangular, trapezoid, Simpson's),	
8	20 Oct	Revision session	
	22 Oct	Midterm exam	
9	27 Oct 29 Oct	Ch4: Numerical Integration II: Gauss quadrature	A6

10	3 Nov 5 Nov	Ch5: Solving Linear Systems I: Basics of matrix analysis	A7
11	10 Nov 12 Nov	Ch5: Solving Linear Systems II: Direct methods,	A8
12	17 Nov 19 Nov	Ch5: Solving Linear Systems III: Iterative methods	A9
13	24 Nov 26 Nov	Ch6: Approximation Theory I	A10
14	1 Dec 3 Dec	Ch6: Approximation Theory II	
15	8 Dec 10 Dec	Ch6: Approximation Theory III	
TBC		Final exam	

Important Dates

Keep in mind the following important dates:

- Sept 2: first day of classes
- Sept 8: last day to add without instructor approval
- Sept 15: last day to drop without a W on transcript, last day to add without college approval
- Nov 10: last day to drop with W without college approval

5 University Policy Statements

The University's Education & Student life policies are available in the online Policy Library.

The University seeks an environment that promotes academic achievement and integrity, that is protective of free inquiry, and that serves the educational mission of the University. To support this environment, the University seeks a community that is free from violence, threats, and intimidation; that is respectful of the rights, opportunities, and welfare of students, faculty, staff, and guests of the University; and that does not threaten the physical or mental health or safety of members of the University community.

As a student at the University, you are expected to adhere to Board of Regents Policy: Student Conduct Code.

The following links to University Policy Statements are provided for your reference:

- Sexual harassment, sexual assault, stalking and relationship violence
- Equity, Diversity, Equal Employment Opportunity, and Affirmative Action
- Disability Services
- Academic Freedom and Responsibility.

Resources related to mental health, stress management, and counseling can be found at `https://safe-campus.umn.edu/personal-wellbeing`.