

## MA 240: Spring 2025 Differential Equations

Mathematics

Albert Nerken School of Engineering at The Cooper Union

Course Description:

Ordinary differential equations of the first order, linear equations of higher order with constant coefficients, eigenvalues and eigenvectors, first-order systems of linear equations, phase plane analysis for nonlinear two-dimensional systems, Laplace transformation, and Fourier series.

3 credits. Prerequisite: Ma 110, Pre/Corequisite: Ma223

Instructor:

Mili Shah (mili.shah@cooper.edu)

41 Cooper Room 311

Lectures:

Tuesdays 2:00PM-2:50PM, 41 Cooper Room 201

Wednesdays 10:00AM-11:50AM, 41 Cooper Room 505

Office Hours:

Tuesdays 3:00PM-4:00PM or by appointment, 41 Cooper Room 311

Participation:

Please contribute to the classroom environment by asking questions and participating in discussions. Your interaction will be considered when assigning borderline grades, as will improving performance throughout the course of the semester.

Grading:

25% Quizzes, 45% Exams, 30% Final

Homework:

Suggested homework problems will be posted in class. These homework problems will not be graded but are representative of information that is required. Similar problems will be presented on quizzes and exams.

Quizzes:

There will be quizzes based on problems from the previous week given throughout the semester due **Tuesdays at 11:59pm** and posted at

<https://webwork-hosting.runestone.academy/webwork2/cooper-shah-ma240-spring2025>

Your initial login is your Cooper username and your password is your Cooper ID number without the leading zeros. Collectively, these quizzes will constitute 25% of the final grade. The lowest quiz grade will be dropped.

Exams:

Two exams and one final will be given during the semester. You may not use outside resources: calculators, other students, other books, etc. The first exam will constitute 20% of your total grade, the second exam 25%, and the final will constitute 30% of your total grade.

Exam 1: Wednesday, February 19

Exam 2: Wednesday, April 16

Final Exam: Wednesday, May 14

*Note: I reserve the right to adapt exam dates.*

Required Text:

*Differential Equations with Boundary-Value Problems*, Zill, D., Wright, W. and Cullen, M., 8th Edition, 2013.

<https://cooperunion.sharepoint.com/:b:/s/library.department/EagcpupPnN5EhdPXNmVbd1EBgBmWIJJHfYkDvfG1vTPriQ?e=aUgqwy>

Suggested Texts:

Cuoco, A., Waterman, K. Kerins, B. Kaczorowski, E., Manes, M., *Linear Algebra and Geometry*, AMS/MAA, Vol. 46, 2019.

[https://cooperunion.sharepoint.com/sites/library.department/Shared%20Documents/Material%20Repo/Books/Cuoco%20et%20al\\_2019\\_Linear%20Algebra%20and%20Geometry.pdf](https://cooperunion.sharepoint.com/sites/library.department/Shared%20Documents/Material%20Repo/Books/Cuoco%20et%20al_2019_Linear%20Algebra%20and%20Geometry.pdf)

*Interactive Linear Algebra*

<https://textbooks.math.gatech.edu/ila/>

Disabilities:

If you believe you are entitled to an accommodation on assessments through the Americans with Disabilities Act, you must self-identify to the Office of the Dean of Students and meet with me during the first week of the term to discuss arrangements for meeting your accommodation.

## Timeline

Please note that this schedule is tentative and will likely be adjusted as the semester progresses.

| Week      | Topics  | Sections            |
|-----------|---|---------------------|
| 1/21/2025 | Basic definitions and terminology. Initial-value problems. Math Models  | ZWC:1.1-1.3         |
| 1/28/2025 | Solution curves without a solution. Separable first-order equations. Linear first-order equations.  | ZWC:2.1-2.3         |
| 2/4/2025  | Exact first-order equations. Solution by substitution.  | ZWC:2.4-2.5         |
| 2/11/2025 | Linear and nonlinear models. Review of linear combinations.   | ZWC:3.1-3.3         |
| 2/18/2025 | <b>Exam</b>   |                     |
| 2/25/2025 | Linear combinations. Independence/Dependence. Kernel.   | AMS:3.3-3.5         |
| 3/4/2025  | Introduction to higher-order equations. Boundary value vs. initial value problems. Basic theory of linear differential equations. Homogeneous/non homogeneous. The special case of constant coefficients. | ZWC:4.1,4.3         |
| 3/11/2025 | Reduction of order. Undetermined coefficients (both superposition and annihilator approaches). Cauchy-Euler form  | ZWC:4.2,4.4-4.5,4.7 |
| 3/18/2025 | Review of determinants. Eigenvalues. Diagonalization  | ILA                 |
| 3/25/2025 | Linear models. Systems of linear DE by elimination. Preliminary theory of linear systems. Homogeneous linear systems  | ZWC:4.9,5.1,8.1-8.2 |
| 4/1/2025  | <b>Spring Break</b>   |                     |
| 4/8/2025  | Nonhomogenous linear systems. Matrix exponentials   | ZWC:4.6,8.3-8.4     |
| 4/15/2025 | <b>Exam</b>   |                     |
| 4/22/2025 | Introduction to Laplace transform formalism. Inverse transform of derivatives and solution to initial value problems. Operational properties I  | ZWC:7.1-7.3         |
| 4/29/2025 | Operational properties II. Impulsive forcing and Dirac Delta formalism. Introduction to inner product structure and orthogonal functions  | 7.4-7.5,11.1        |
| 5/6/2025  | More on orthogonal functions. Fourier series. Fourier sine and cosine series  | 11.1-11.3           |
| 5/13/2025 | <b>Final Exam on Wednesday May 14</b>   |                     |