Math 613: Advanced Applied Mathematics I Fall 2025

Course Information

Course Location: TIER 111

Course Times: Mon, Thu 4:00pm-5:20pm

Instructor: Jonathan Jaquette (jcj@njit.edu)

Office Location: 624 Cullimore Hall

Office Hours: TBA, and by appointment.

Required Textbook:

- **Title**: Introduction to the foundations of applied mathematics
- **Author**: Holmes, Mark H
- **Publisher**; **Edition:** Springer, 2nd Edition
- **ISBN #:** 9783030242602; 9783030242619

Course Website: All course announcements, and supplemental materials will be posted through the course Canvas page.

Course Content & Objectives

Concepts and strategies of mathematical modeling are developed by investigation of case studies in a selection of areas. Consistency of a model, nondimensionalization and scaling, regular and singular effects are discussed. Possible topics include continuum mechanics (heat and mass transfer, fluid dynamics, elasticity), vibrating strings, population dynamics, traffic flow, and the Sommerfeld problem.

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

- Solve quantitative problems in applied math.
- Critically read graduate textbooks, summarize the major points, and discuss the finer details.
- Prepare and deliver short presentations on applied mathematics and modeling.

Course Pre-Requisites:

MATH 331 and MATH 337, or departmental approval.

Policies

DMS Course Policies: All DMS students must familiarize themselves with, and adhere to, the Department of Mathematical Sciences Course Policies, in addition to official university-wide policies. DMS takes these policies very seriously and enforces them strictly.

Grading Policy

The final grade in this course will be determined as follows:

Presentations & Participation	15%	Homework	20%
Midterm exam	30%	Final Exam	35%

Your final letter grade will be based on the following tentative curve

A	88-100	**C**	62-67
B+	82-87	**D**	55-61
B	75-81	**F**	0-54
C+	68-74		

Exams

There will be one midterm exam held in class during the semester and one comprehensive final exam. Exams are held on the following days:

Midterm Exam	Oct. 23, 2025
Final Exam Period	Dec 14-20, 2025

The final exam will test your knowledge of all the course material taught in the entire course. Make sure you read and fully understand the Math Department's Examination Policy. This policy will be strictly enforced.

Makeup Exam Policy: To properly report your absence from a midterm or final exam, please review and follow the required steps under the DMS Examination Policy found here:

http://math.njit.edu/students/policies_exam.php

There are NO MAKE-UP MIDTERM EXAMS. Students who fail to take an exam will receive a score of zero unless they have a legitimate excuse.

Academic Integrity

Academic Integrity is the cornerstone of higher education and is central to the ideals of this course and the university. Cheating is strictly prohibited and devalues the degree that you are working on. As a member of the NJIT community, it is your responsibility to protect your educational investment by knowing and following the academic code of integrity policy that is found at: NJIT Academic Integrity Code.

Please note that it is my professional obligation and responsibility to report any academic misconduct to the Dean of Students Office. Any student found in violation of the code by cheating, plagiarizing or using any online software inappropriately will result in disciplinary action. This may include a failing grade of F, and/or suspension or dismissal from the university. If you have any questions about the code of Academic Integrity, please contact the Dean of Students Office at dos@njit.edu

Working in Groups

I **highly recommend** finding a friend or two in this class and studying together! It makes doing homework more enjoyable (or less miserable?), and helps you learn difficult material. Even if you think you know everything, explaining concepts to someone else will help you master the material.

That said, the homework you turn in must be your own. Don't just copy someone else's work -- be it someone else in the class or someone online. If you get a significant idea or assistance from a classmate or an outside source, **BE SURE** to reference them. Citing your sources is one of the best way to avoid representing other's work as your own. While group work is great for preparing presentations and doing homework, the work you do on the midterm/final exams should be all your own.

Seminar Format

This course is a seminar and, unlike a traditional course, almost all of the talking in our meetings is done by the students. The main work of the seminar meeting will be presentations on selected topics, discussion of the readings and presentations, discussion of student generated questions, and presentation and discussion of homework problems. I'd like the seminar atmosphere to be lively but not intimidating. The goal of the group should be to push everyone's understanding. If something isn't clear, we need to stop and clarify.

In this format, the seminar members will be expected to have mastered all the basic background material before seminar, and the seminar meeting will be devoted to reinforcing, extending and enhancing your knowledge of the seminar topics. Students presenting material in any given week must thoroughly prepare those presentations in advance. Students not presenting material should still study all of the material to be presented in advance so that they may ask good questions and participate fully in the discussions. If you are unable to attend class for any reason, please contact me as soon as possible.

Meeting Organization

Below is an example agenda for one week's seminar:

Monday Class:

- Student presentations (50-60 min)
- Discussion of students' prepared questions on the reading (20-30 min)

Thursday Class:

- Plan which problems to discuss (5 min)
- Discussion of homework problems (65 min)
- Closing, and planning for the next week (5 min)

Reading Questions:

Each week there will be about 20 pages from the book that everyone should read by Monday.

By Monday morning (before noon!), each student must post on the class's online discussion form **at least 3 questions** they had from the reading. As an alternative to only asking questions on the online forum, you may ask x many questions of your own, and post y many answers/responses to other students' questions so long as both $x \geq 1$ and $x + y \geq 3$. My suggestion would be to compile your list of questions **as you are reading the week's material**.

At the end of class on Monday we will discuss the reading questions. Ideally this will be an organic discussion, with one student posing their question about the reading, another student agreeing they found that part confusing, and another student saying how they think that question about the reading could be answered, leading into somebody else asking another question they had about the reading.

To receive a full participation grade, you must both post your reading questions online and **speak at least once in class**. If the discussion lulls, I may call on someone who hasn't spoken yet to ask their reading question. Also, if you had a question about the reading but then figured it out, that still counts!

Homework Problems

Each week there will be homework problems to accompany the reading. You are strongly encouraged to work together on problems.

At the beginning of each Thursday seminar, I will put the list of homework problems on the board, and we will divide into small groups for presenting a given homework problem to the class. (You'll let me know the problems you feel most comfortable with and I'll respect your preferences. Difficult problems we can work on together.)

To make efficient use of class time there will be two rounds of problem presentations. To describe a typical week's homework discussion, suppose there six problems assigned that week, #1-#6.

- First we break into groups, with groups of 1-3 students to present each problem.
- Then each group meets for about 10 minutes to discuss their answers to their assigned problem and who will present which part of the problem.
- Then groups #1-#3 will simultaneously write their solutions on the white board. The rest of the groups continue to discuss homework problems
- When groups #1-#3 are finished writing, they will present their homework problem in turn. Questions from the rest of the class are strongly encouraged!
- Next, groups presenting on problems #4-#6 will simultaneously write their solutions on the white board. Meanwhile groups #1-#3 discuss other homework problems.
- When groups #4-#6 are finished writing, they will present their homework problem in turn. Questions from the rest of the class are strongly encouraged!

A writeup of the week's homework problems will be due after class on Friday at 11:59pm, late work will be penalized. (Your write up should be mostly be complete by class on Thursday.) Homework will be submitted through the Canvas course website, and primarily graded on completeness (e.g. good/okay/needs work). As we will go over the solutions, you will receive feedback on the correctness of your work in class.

Presentations

Many seminars will include short presentations prepared by students. Presentations may include discussing a section from our text or another book, readings from journals, or examples relating to the week's reading. There will be about 2 presentations per week, and each student is expected to present at least once before the midterm, and once after the midterm. At the beginning of the semester we will decide on who is presenting on which weeks. If two students wish to swap weeks that is fine, just let me know.

In weeks that you are giving a presentation, you are **REQUIRED** to talk to me in office hours beforehand to discuss your talk outline/ask questions about the material/etc. Each presentation should be about 15 minutes and leave 5 minutes for questions. You should not go overtime; I will set a timer. Student presentations will be graded on their **content**, **organization**, and **communication** according to the rubric on the last page of the syllabus.

Additional Presentation Advice

- Practice your talk to make sure the timing is right!
    - Be aware, it takes longer to give your talk while writing on the board, than it does to give your talk while reading from your notes.
- Also, it takes more time than you think for: the listener to wait for the speaker to write something down, copy it into their notes, and then try to understand it. As a result, a good chalk talk needs to have concise board work.
- One way this manifests itself is in writing style. The writing style of blackboard presentations is different from text-book mathematical writing. For example, on a piece of paper one typically writes in complete sentences, in the second person plural, and one typically can fit more words on each line. On the chalk board, it is common to write in shorter sentences and in the

imperative. (eg Writing “We simplify the above equation to obtain the following:” versus writing “Simplify!”).

- When drafting presentation notes, it's important to think about how the board will look for the audience taking notes. People generally do not write down things that the presenter doesn't write on the board. I try to write down verbatim what I plan to write on the board. If I have some additional notes for what I want to say but not write, I'll write them in a different color.
- One of the things to be conscious of is how the text layout on an 8.5x11 piece of paper is different then how it gets transcribed onto the board. Being mindful of this will help the translation from notes to chalk go more smoothly. What I do is fold my piece of paper into quadrants, and then estimate that each quadrant will correspond to one column of blackboard writing.
- Some more best practices:
    - Try not to stand in front of what you’re writing while you write it.
    - **TALK WHILE YOU WRITE!** Nobody likes dead air.
    - Unless you make a mistake, **DO NOT ERASE!** If it was important to write on the board, leave it up. It takes time to write things down; your note-taking audience will thank you.
    - Whenever possible, **RESUSE MATERIAL!** Using one example throughout your presentation is simple and efficient. Using many examples takes a lot more time.
    - When possible, **REFER BACK**, but not too far back. If you write down an equation that gets used later AND its still on the board, its much easier to just point to it rather than copy it over again.
    - Whenever possible, **AVOID LONG COMPLICATED FORUMLAS!** If the formula doesn’t get used again and is not insightful, it can probably be avoided.
    - To help keep your board space organized, **DRAW SEPARATING LINES!**

Tentative Schedule of Material

Week	Mon	Thurs	Topic	Reading
1	---	9/4	Introduction	Ch 1
2	9/8	9/11	Dimensional Analysis	Ch 1
3	9/15	9/18	Dim. Analysis & Perturbation Methods	Ch 1&2
4	9/22	9/25	Perturbation Methods	Ch 2
5	9/29	---	Perturbation Methods	Ch 2
6	10/6	10/9	Kinetics	Ch 3
7	10/13	10/16	Kinetics	Ch 3
8	10/20	10/23	Kinetics / Midterm	Ch 3
9	10/27	10/30	Diffusion	Ch 4
10	11/3	11/6	Diffusion	Ch 4
11	11/10	11/13	Traffic Flow	Ch 5
12	11/17	11/20	Traffic Flow	Ch 5
13	11/24	11/25	Traffic Flow & Continuum Mechanics (1d)	Ch 5&6
14	12/1	12/4	Continuum Mechanics (1d)	Ch 6
15	12/8	12/11	Continuum Mechanics (1d)	Ch 6

Student: Title: Date:

	UNSATISFACTORY	PROFICIENT	Comments
Content			
Mathematical Concepts	Quotes long passages from text; No connections are made between concepts; Displays errors in knowledge of mathematical concepts.	Clearly articulates, and develops connections among mathematical concepts.	
Mathematical Procedures	Has difficulty explaining mathematical procedures.	Gives explanations/intuition for why mathematical procedures are valid or appropriate.	
Mathematical Representations	Representations (e.g. equations, diagrams) are inappropriate / unclear / given without explanation	Representations are clear and appropriate, with explanations of significant elements.	
Examples	No examples or inappropriate examples.	Well-chosen and well-sequenced examples.	
Organization			
Presentation Structure	The presentation has no clearly defined structure; the structure is chaotic.	The presentation has a clearly defined structure with smooth transitions.	
Timing	Greatly runs over time; Ends abruptly leaving material uncovered; Ends much too early.	Talk ends on time, leaving time for questions. Each topic is given an appropriate amount of time.	
Communication			
Mathematical	Consistently inappropriate use of mathematical terminology and/or symbols.	Appropriate use of mathematical terminology and symbols.	
Written	Writing is illegible/ not adequately used to record information.	Communicates clearly and effectively. Legible and grammatically correct.	
Oral	Does not speak clearly; Rarely faces audience.	Speaks clearly and effectively in a sophisticated/engaging manner.	

Overall Score/Comments: