MATH-383L: DIFFERENTIAL EQUATIONS LAB

The University of North Carolina – Chapel Hill

Fall 2022

Instructor:	Dylan Bruney	**Email:**	bruney@live.unc.edu
Class Location:	Phillips Room 383	**Class Day/Time:**	Tuesday, 3:30-5:30
Office Hours	TBD	**Credit Hours:**	1
Office Location:	TBD	**Zoom ID:**	https://unc.zoom.us/j/4215882243

Course Website: https://tarheels.live/bruney/math-383-lab-fall-2022/

COURSE DESCRIPTION

This is an optional supplement to MATH-383, Differential Equations, designed to teach the interested student how to perform basic scientific computing tasks using the industry-standard MATLAB computer program. It is not intended to be taken on its own as an overview of scientific computing, but rather to explore the intersection of computation and theory in this specific application.

Scienfic computing is the sub-discipline of computer science that focuses on the use of computers to solve physical problems arising in the sciences, and is the oldest and (arguably) best-studied part of the field. However, as a result it is highly specialized in its niche, and the skills within it are usually not transferable: don't expect to get a job writing iOS apps at Google if you ace this class! The upside, however, is that it is usually much easier for the mathematically inclined to become good at scientific programming than it is for a computer scientist to become good at mathematics. My goal, then, is to give you the tools you need to be a good scientific programmer, and provide you a useful jumping-off point to introduce computing as a tool to solve mathematical problems in your career.

COURSE OBJECTIVES

1. The successful student will gain a familiarity with basic MATLAB commands and uses
2. The successful student will learn how to perform basic programming structure and operations
3. The successful student will develop better understanding of differential equations
4. The successful student will develop their problem-solving skills in general

PREREQUISITES

MATH-383 is a pre/corequisite of the class. Prior programming experience or computer science courses is not needed, though it will be helpful if you do have it!

CLASS RESOURCES

- ZOOM: I will be at conferences periodically throughout the semester, so Zoom will be required for a few classes. Please download it from https://software.sites.unc.edu/zoom and check to make sure it works in advance of class.
- MATLAB: https://software.sites.unc.edu/software/matlab/: This class will be predominantly taught in MATLAB, and it is needed to complete the homework assignemnts. Occasional examples may be demonstrated by me in Mathematica, but it is not required for assignments
- TEXTBOOK: There is no formal textbook. However, in the course of writing code, every programmer will invariabl find themselves referring to language-specific documentation. MATLAB's is available at www.mathworks.com/help/matlab

GRADING POLICY

Weekly Assignments = 70%

Final Project = 30%

Weekly Assignments

As this is a lab course, 70% of your grade will be based on the weekly (or occasionally biweekly) assignments, which will require you to write MATLAB code in order to solve one or two problems. You will be required to submit both a copy of your code- so I can run it and verify it works- and the output you receive (which could be a number, a graph, a file, etc.) If your code runs on my machine and produces a correct answer, you will be guaranteed to receive at least an 80% on the assignment. Points can still be deducted for sloppily written code, slow execution, poorly-scaling algorithms, improper use of built-in functions, etc. Extra credit will be sparingly given at my sole discretion for particularly clever or elegant solutions to problems. All grades will be posted on sakai.

Final Project

In groups between 3-5 (this may change) you will present a project and provide a short write-up (no more than 3 pages) discussing any application of Matlab to differential equations in a physical system that you and your team find interesting. The topic or model does not need to be excessively complex. This can be an original topic, or a review of an existing application. To receive credit, the topic must first be approved by the course instructor via email. A digital copy of the write-up should be submitted to the course instructor by November 27th. Points will be awarded based on the technical discussion as well as overall creativity. Be sure to appropriately cite any references. Topics can include (but are not exclusive to) specific applications to: aerodynamics and fluid flow, astrophysics, biological system models, chemical reactions, classical mechanics, ecosystem models, epidemiology, sports, and transportation.

The course will initially be curved such that 90% and above is an A, 80% above is a B, etc. Note that I may choose to curve more generously at my sole discretion, but I will never curve less generously (eg, a 90% is always an A, but perhaps an 87% is an A as well). I may also opt at my sole discretion to assign plus and minus grades.

CLASS STRUCTURE

The usual class structure will consist of a brief, 10-15 minute review of the homework assignment due the prior week, with an explanation of some of the possible methods and solutions that could be used to solve it, and fielding questions from students on difficulties they had achieving it. Following that, there will be a short lecture, usually no more than 30 minutes, covering the coding theory or practice and laying out the problem statement that we will be trying to solve in the current assignment. The balance of time will be spent "open coding", where students will attempt to work on their assignment and I will field questions. Every assignment will be written so that it is theoretically possible to complete entirely in class- but in practice, the first 10% of programming time is spent writing the code and the next 90% is spent debugging it to get it to work!

TECHNOLOGY POLICY

As this is a programming lab course, you are generally expected to use a computer in order to solve problems, though certainly if you wished to spend hours executing an algorithm by hand you are welcome to. A webcam, speakers, and microphone are also needed for Zoom.

HONOR CODE

All students are expected to conduct themselves within the guidelines of the UNC Honor System. All academic work should be done with the high level of honesty and integrity that the University demands. Your programming assignments are expected to represent YOUR original work- not the work of people you found on the Internet or snippets you copied from StackOverflow. If I suspect you have been plagiarizing, you will receive an F on the assignment, and repeat offenders will receive an F in the course.

ACCOMMODATIONS

If there are special or unique circumstances that you feel will affect your performance in this class, please contact the staff at the Academic Success Program, (919) 966-2143, or at ARS (919) 962-8300, so that we can work together to meet your needs.

COVID-19 MISCELLANY

This class will be held mostly in-person, so please be prepared to attend in-person and feel free to wear a mask in class if you feel safer doing so. If at any point in the semester you are unable to attend in-person due to contracting Covid-19 and needing to isolate for 5 days, please plan to obtain any class notes from a classmate, and email me to let me know about your absence and ask any remaining questions. Still, please familiarize yourself with the University's available COVID-19 resources at https://www.unchealthcare.org/coronavirus/.

TENTATIVE CLASS SCHEDULE

Week	Date	Topic
1	8/16	Class Overview and Introduction to MATLAB
2	8/23	Functions In MATLAB
3	8/30	Root Finding: Bisection
4	9/6	*University Wellness Day, NO CLASSES!*
5	9/13	Root Finding: Newton's Method
6	9/20	Euler's Method
7	9/27	Adam's Bashford
8	10/4	Runge-Kutta
9	10/11	Backwards Euler
10	10/18	Basics of Linear Algebra in MATLAB
11	10/25	Linear Algebra and ODEs
12	11/1	Modeling Real Systems: I
13	11/8	Modeling Real Systems: II
14	11/15	Additional Topics
15	11/22	Final Project Workshop
16	11/29	Final Project Presentation

SYLLABUS REVISIONS

The Instructor reserves the right to change or modify the syllabus at his discretion as events develop, including but not limited to test dates, class structure, grading policy, and more. Any changes made will be announced in class and via email at least one week before the relevant date in the current syllabus.