

## Math 20D Summer Session 1 2022 Term Paper Instructions

**Due: Monday July 25<sup>th</sup>, 11:59 pm on Canvas under Assignments**

You are to write a short expository mathematical paper (3 page minimum) on a topic related to differential equations. The point of this paper is to allow you to adapt the course to your own interests and allow you to explore a topic outside of the material covered in class; I also believe that becoming familiar with mathematical writing, outside of just homework, is useful for your academic development. There are a variety of topics that you could choose. Below, I've provided some possible suggestions for topics, or you can choose your own (if you are unsure if your topic is okay, please feel free to email me).

The paper should be typeset; for example, either using LaTeX or using Microsoft Word with the Insert > Equations for any mathematical text. I will be reading and grading these personally; if you make an honest effort, you will receive full credit for this portion of the grade. Please cite any references at the end of your paper, and also include in-text citations where appropriate. **Plagiarism of any form will not be tolerated and will result in an academic integrity violation.**

Possible Topics:

- Pick a particular differential equation or class of differential equations (outside of the ones covered in class) and examine its properties (existence of solutions, solution properties, methods for solutions, etc.).
- Pick and discuss a method of solving certain differential equations not discussed in class (e.g., Fourier transform).
- Partial Differential Equations (the generalization of ordinary differential equations to allow both space and time derivatives; these describe “fields” evolving in space and time, such as electromagnetism, fluid flow, the heat equation, etc.).
- Nonlinear Dynamics such as chaos (e.g., the Lorenz attractor), stability, bifurcation theory.
- Pick and discuss a differential equation related topic related to your field of study or interest.

Examples

- Engineering: Control theory, circuit analysis, continuum mechanics (solids, fluids, elasticity), Thermodynamics
- Physics: Newton's equations, Lagrangian and Hamiltonian mechanics, Maxwell's equations, Schrödinger's equation
- Biology: Predator-Prey models (e.g., Lotka-Volterra model), Potential theory (the Hodgkin-Huxley model), Bacterial Growth (thanks to C. Chung for recommending this topic)
- Finance: Stochastic differential equations
- Numerical solution or “integration” of differential equations for differential equations that do not have analytic solutions (which, it turns out, is most of them). For example, the finite difference method or the finite element method.
- The history of differential equation (or history of a particular differential equation).
- Pick a topic of your own; if you are unsure if your topic is appropriate for this paper, feel free to contact me.