Introduction to Partial Differential Equations

Summer 2018

Instructor:	Kevin O'Neill	**Time:**	MW 8:10-10:00, TTh 8:10-9:00
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Course Description: This course is an introduction to the subject of Partial Differential Equations (PDE). Loosely speaking, a PDE is an equation which tells you about a function of multiple variables through its derivatives. PDE are useful in applied fields ranging from physics to engineering to finance as well as an active area of mathematical research. In this course, we will study properties of some basic PDE (the wave, heat, and Laplace equations), how to solve initial and boundary value problems, and other various topics to expose you to a large and diverse field of mathematics.

Textbook(s): The required textbook for this class is

Partial Differential Equations: An Introduction, by Walter A. Strauss, 2nd Edition.

This textbook is more expensive than ideal, so I would recommend doing the full Internet search for the cheapest price you can find. There are websites dedicated to this purpose, which you can find if you ask anyone whos still a college student. Alternatively, you may purchase the 1st edition. I hear that previous students in this class have done just fine following that route, though please let me know if you do this so I can make sure you end up doing the right homework problems.

Generally I would suggest sticking to one textbook at a time. But if you are looking for an additional source, I have been recommended a book by Peter J. Olver, which can be found at the following link and downloaded for free on campus via SpringerLink: http://www.math.umn.edu/~olver/pde.html

Berkeley Time: For those of you enrolled at other institutions and taking your first course at Berkeley, please note that it is tradition here to start classes 10 minutes after the scheduled time. So our class will begin at 8:10 am each morning and you will have plenty of time to make it to your 10:00 am Monday Underwater Basket-weaving class because it actually starts at 10:10 am.

Office Hours: Office hours will be held outside the Free Speech Movement Café immediately after class ends Monday through Thursday. Each session will be an hour long (so MW 10:05-11, TTh 9:05-10).

Prerequisites: Math 53, 54. In particular, you should be familiar with partial derivatives, Green's/Stokes' theorem, and Fourier series, though I promise we will review these as they come up.

One class which is not required is Math 104: Intro to Analysis. A rigorous approach to PDE requires some analysis and some proofs, so when these issues come up, I will attempt to wave my hands in a way that alludes to the actual proof for those of you with more background.

Honor Code: The UC Berkeley Honor Code states:

As a member of the UC Berkeley community, I act with honesty, integrity, and respect for others.

Regardless of whether you attend UC Berkeley during the school year or are just here for the summer, you are bound by the honor code. For this class, I expect you to write the names of anyone you received help from of collaborated with on your homework assignment as you turn it in. Also, cheating will not be tolerated, any act of it will result in the highest punishment allowed, and I hope this is the last time I ever have to say anything about this.

bCourses: The course website is: https://bcourses.berkeley.edu/courses/1471707. On it you will find resources such as: this syllabus, homework assignments, lecture notes, practice midterms/final and solutions, midterm/final solutions, and various other things that come up during the semester.

Piazza: I have set up a Piazza page at https://piazza.com/berkeley/summer2018/math126/home

For those of you who haven't used Piazza before, it is a discussion board where you may ask any questions related to the course and have them answered by a combination of your classmates and myself.

I am happy to answer questions over email, but if it is something your classmates may want to know the answer to, please ask it first on the Piazza page.

Lecture Notes: Before each lecture, I will scan my lecture notes and upload them to bCourses. The online files will be *exactly* what I write on the board during class. My purpose in doing this is to give you the opportunity to just focus on what I am saying in class and understanding the material rather than be distracted by notetaking. (However, you are still welcome to take notes, of course.)

Grading Policy:
Homework: 25%
Midterm: 30%
Final: 45%

Homework: There will be biweekly homework for this course, generally due on Mondays and Fridays. (Exact time it is due and method of submission will be determined by the start of class on June 18.)

You will only be graded on a subset of the problems you turn in, but you will be graded on the quality of your answers. A general standard to follow for all work done in all math classes is to write your work so that your classmates could understand what you are doing just from reading it. Use words! Here are some useful tips from my undergraduate advisor: https://www.math.hmc.edu/~su/math131/good-math-writing.pdf.

No late homework will be accepted. However, your single lowest homework will be dropped.

If you have particular questions about how to solve a problem or justify a step, feel free to ask the grader by writing "Question for Grader:..." on your assignment.

Midterms and Final: The midterm will be on Thursday, July 12 and cover all preceding material. The final on Thursday, August 9 and will be cumulative, but emphasize the second half of the course (except the last lecture or two).

The exams will be 2 hours long and in our usual classroom.

Advice: The best advice I can give is for you to stay caught up. I know it's rather clich to say that the summer goes by quickly, and if you get behind, it is nearly impossible to get caught up. But it's true. Even teaching during the school year, the number one regret my students have had is falling behind. Remember, math tends to build on itself. Second, I advise you to realize that math is not just about doing, it's about understanding. Just memorizing the techniques will not help you when you are confronted with a slightly different situation on an exam, or a new, more abstract, concept later on in the course. I will do my best to give homework assignments which help you practice this greater understanding.

Disabilities: Any student needing special accommodations is encouraged to inform me as soon as possible, in particular, with a letter from the DSP well in advance of any exam if extra time is needed.

Class Schedule: Here is a tentative schedule for the class. It may change slightly depending on how the course goes. Be sure to check the bCourses page for updates, and details for homework assignments. However, midterm and final dates are fixed.

		Sections	Topic	HW Due
6/18	M	1.1, 1.2	What's a PDE? + Transport Equations + ODE Review	
6/19	T	1.3, 2.1	Wave Equation I	HW0 (see e-mail)
6/20	W	2.1, 2.2	Wave Equation II	
6/21	Th	1.3, 2.3	Diffusion Equation I	HW1 (Friday)
6/25	M	2.4, 3.1	Diffusion Equation II	HW2
6/26	Tu	3.2	Wave Equation on the Half-Line	
6/27	W	3.3	Diffusion with a Source	
6/28	Th	3.4	Waves with a Source	HW3 (Friday)
7/2	M	4.1, 4.2	Separation of Variables	HW4
7/3	Tu	5.1-5.3	Fourier Series	
7/4	W	Holiday		
7/5	Th	5.4, 5.5	Convergence of Fourier Series I	HW5 (Friday)
7/9	M	6.1	Laplace's Equation I	
7/10	Tu	5.4, 5.5	Convergence of Fourier Series II	
7/11	W		Review	HW6
7/12	Th		**Midterm**	
7/16	M	6.2, 6.3	Laplace's Equation II	HW7 (short)
7/17	Tu	7.1	Math 53 Review and Green's First Identity	
7/18	W	7.2, 7.3	Green's Second Identity and Green's Functions	
7/19	Th	7.4	Green's Functions for the Half-Space and Sphere	HW8 (Friday)
7/23	M	8.1, 8.2	Finite Difference Method for Diffusion	HW9
7/24	Tu	8.3	Finite Difference Method for Waves	
7/25	W	9.1	The Wave Equation in Higher Dimensions	
7/26	Th	9.2	Solving the Wave Equation and Huygen's Principle	HW10 (Friday)
7/30	M	9.4, 12.1	Diffusion/Schrödinger in 3D and Intro to Distributions	HW11
7/31	Tu	12.2	Green's Functions, Revisited	
8/1	W	12.3	The Fourier Transform	
8/2	Th	12.4	Quick Solutions to PDE	HW12 (Friday)
8/6	M	14.1	Shock Waves	HW13
8/7	Tu		Special Review Lecture	
8/8	W		Review Discussion	HW14 (short)
8/9	Th		**Final**	