SYLLABUS FOR MATH 442: INTRO TO PDES

Time/Location: The course will be online. There will typically be two recorded lectures posted weekly, averaging about 70 minutes in length. We will also hold two weekly meetings over Zoom on Monday and Wednesday mornings. These meetings will be split into two parts, one corresponding to each section (though you are free to attend either meeting). The first will begin at 10 AM central time, and the second will begin at 11 AM central time.

Our Zoom meetings are intended as question and answer sessions to augment the pre-recorded lectures. Our meetings will be open to discussion and questions about material covered in preceding lectures. These meetings are optional but encouraged, and will be recorded to the Zoom cloud for those who cannot make it (the recordings will be accessible only to students in the class).

Instructor: Alex Barron, email: aabarron@illinois.edu.

Course Content: This course is an introduction to the mathematical analysis of partial differential equations (PDEs), with some additional emphasis on the physical meaning and derivation of PDEs. We will in particular focus on the wave, diffusion, and Laplace equations in different domains. We will discuss various methods for solving these equations and for analyzing properties of solutions to these equations. We will also spend some time developing the basic theory of Fourier series and the Fourier transform, since these are essential tools in the analysis of PDEs. Indeed, a portion of the class will be devoted to covering the convergence of Fourier series in some detail.

When first studying PDEs it is important to strike a good balance between questions which are 'computational' (e.g. given an equation, can you calculate a particular function that solves it?) and questions which are more 'theoretical' (e.g. what properties does a generic solution to a particular equation have?). We will encounter both types of questions throughout the semester, and we will attempt to study both types of questions from a rigorous mathematical perspective. However we will occasionally omit technical details from proofs if they distract too much from the flow of ideas.

We will follow the basic outline of the syllabus found on the department's syllabus page, which can be viewed by clicking here. An outline of topics for future weeks will also be available on our website.

Website: The class website is https://sites.google.com/view/ ma442s21. Here you'll be able to find homework assignments, video lectures, and other course information. Please check the website regularly.

Text: *Partial Differential Equations: An Introduction* by Walter Strauss, **2nd Edition**. Most of the class will be spent on Chapters 1-6. Time permitting we will also discuss selected material from chapters 7, 9, or 12, possibly including: the basic theory of the Fourier transform and its

use in studying PDEs; Green's identities and the Laplace equation in three dimensions; the basic theory of the Schrodinger equation.

Technology requirements: Students will need to have access to an internet connection which is fast enough to stream videos and Zoom meetings. We will use Box for assignment submission (all students should have access to Box through the university, see the relevant section below). Students should also have a device which allows them to scan their work into a pdf document for submission. There are several free scanning apps available for smart phones.

Please do not hesitate to contact me if you encounter any technological obstacles. We will try to figure out a way to accommodate any difficulties.

Mathematical prerequisites: The only formal prerequisite for the class is an introductory course in ordinary differential equations on the level of Math 285, 286 or 441. In addition it will be necessary to have a strong understanding of multivariable calculus and the basic theory of infinite series. It will also be helpful to be familiar with some topics from linear algebra (in particular orthogonality, eigenvectors, and linear transformations). However a full semester of linear algebra is not required, and we will make sure to review any linear algebra tools before using them.

Online Forum: We will have an online forum on Piazza for the class. You can use this forum to post any questions you may have about class material. I will try to respond within a reasonable amount of time.

You can join the forum at the link piazza.com/illinois/spring2021/math442. You will need the following access code: 451972

Submitting assignments: All homework assignments and exams will be submitted online. Each student will have a dedicated Box folder which they will use for submission. Students will be required to submit **pdf scans** of their assignments, so make sure that you have the means to upload a pdf scan of your written work. If you have any technical obstacles please to not hesitate to contact me – we will be able to work out an alternative.

At the beginning of the semester you will receive an invite to activate your Box folder for the class. In order for this to work you first have to activate your university Box account at https://box.illinois.edu/ (if you haven't done so previously). Please do this as soon as possible. I will send out reminder emails when the semester begins.

Your Box folder will only be accessible by the TA, the instructor, and yourself.

Exams: There will be two midterms and a final exam, all given online. The exam dates will be announced shortly and posted on our website.

The midterms will be designed to be 90-minute exams and the final will be designed as a 3-hour exam. Prior to a midterm exam date students will choose a designated four-hour block of time in which to take the exam. You will have all four hours to take the exam, but be warned that you must submit the exam by the end of your alloted time period – so make sure to leave time to scan and upload your solutions! (For more on submission policies see the section above). The final exam will be delivered in the same way but you will have a larger block of time (the current plan is to give 6 hours as long as the midterms go smoothly).

Evaluation: The final grade will be determined as follows:

- Homework: 25 %
- Midterm 1: 20 %
- Midterm 2: 20 %
- Final Exam: 35 %

The **guaranteed** letter grade cut-offs are as follows:

- A range: 90 - 100 %
- B range: 80 - 89 %
- C range: 65 - 79 %
- D range: 58 - 64 %

The ± range will be determined by dividing the above ranges into thirds. It is likely that I will lower the above advertised cut-offs by a few points, scaled based on the overall class performance (note that 'likely' is not the same as 'guaranteed'!).

Homework: Problem sets will be assigned weekly. The problems will be a mixture of textbook exercises and additional problems that I will write. On a typical week your homework will be due on **Fridays**, submitted in your Box folder as discussed above. I will also routinely post **suggested problems**, which are recommended to help you learn the material and study for exams.

It is generally better to spend time *each day* working on homework problems, since this gives you enough time to think through and absorb the course material. Note that it is usually recommended that one spends 2-3 hours studying per hour of lecture, and it is usually better to spread this time out over the week (instead of working on an entire assignment the night before it is due).

Late homework will not be accepted. In order to accommodate unforeseen circumstances I will drop your lowest homework grade when calculating your averages, but otherwise you are expected to turn in all of your homework assignments on time.

Class Moodle: You will be able to keep track of your homework grades on the class Moodle. Your graded assignments will also be uploaded to your Box folder.

How to Succeed: The study of partial differential equations is challenging. You will likely have to devote more time towards understanding the material in this class than you have in some previous math classes. This is the nature of the subject, and you should not be discouraged if you do not understand everything immediately.

When studying for this class you should devote a significant portion of your time to working on problems as you review the material; it will not suffice to memorize a selection of formulas or theorems if you do not get enough hands-on practice working on problems. The assigned and suggested exercises each week will be a good summary of the type of work you are expected to be able to do to succeed in this class.

It is a myth that some people are simply 'good' or 'bad' at math, and that those who are 'bad' cannot get better; if you put in the time and practice you can succeed in the course. As mentioned above, I suggest that you (i) actively work on a lot of problems as you learn the material, and (ii) ask me a lot of questions about these problems, whether or not you think you

understand them. Weekly office hours and lecture discussions are designed to help you with this.

On Collaboration, Online Cheating, and the Academic Code: Students are encouraged to work together on problem sets and to talk with one another about course material, but the final assignments should be written up individually. Copying another student's completed assignment is plagiarism and a violation of the academic code (even if you worked together on the problem!). You must write up your final assignments without any collaboration. All students should also be aware of the university's academic integrity guidelines.

It is occasionally tempting to look up solutions to homework problems on the internet. This is cheating and moreover a waste of time; you will not learn the material if you simply copy solutions, and you will have trouble passing exams if you don't spend time throughout the semester thinking about the assigned homework problems.

If you are caught plagiarizing a homework solution the case will be treated seriously as an academic code violation, and may result in anything from a failing grade on the assignment to a failing grade in the class. **Any student who is proven to have used an online service/site (e.g. Chegg or stackexchange) to solve an exam problem will immediately receive a failing grade in the class.**

Accommodation for Exams: Students who are allowed extra time on exams through the Division of Disability Resources and Educational Services (DRES) should contact me directly before the exam days and we will work out extra accommodations.

If you have any potential conflict with the final exam (once it is scheduled), please inform me. All of our midterms will be given in place of our usual lectures/meetings, so you should have no scheduling conflicts with these exams. However, if you happen to have three or more exams within a 24 hour period of one of our midterms you qualify for a conflict and can reschedule the exam. If this is the case please contact me as soon as possible before the exam day.