Kennesaw State University
College of Science and Mathematics
Department of Mathematics
Spring Semester 2025
MATH 4310 (Section 51): Partial Differential Equations

Contents

1. (Un)popular Answers to Popular Questions

1. *What is happening when? When are things due?* See the contact information in Section 2 and the calendar in Section 8.

2. *What is my grade?* See the formula at the start of Section 5. Your grades are on D2L.

3. *What and where are the course materials?* See Section 4. Your grades and solutions to problem sets and exams are password-protected on D2L. Everything else (such as the daily log, problem sets, and exam information documents) is on the course website.

4. *How should I write an email to you?* See Section 6.3. I appreciate salutations.

5. *How should I be using my time?* See Section 6.4 for a workload breakdown.

6. *I can't come to class today. What should I do?* Read, when posted, the daily log line by line (see Section 6.4 for reading guidelines); email questions and visit during office hours to discuss specific topics that you have studied in advance.

7. *All the notes are online. What's the point of coming to class?* Focus and interaction. Being in class lets you *focus* specifically on course material and *interact* with me and your classmates. Low attendance typically correlates to low grades.

8. *Can I turn in a problem set late?* Possibly. See Section 5.2.5 for the policy on pushing a problem set back.

9. *Why are you being so picky with the formatting of the problem sets and that "complete sentence" requirement?* For your benefit and for mine: to make your work easier for you to reread later in the future and for me to parse for credit, and so that you can continue to grow into the strongest writer and expositor possible. See also Sections 5.2.1 and 5.2.2.

10. *Can I make up an exam?* Quite possibly. See Section 5.4.2 for the procedures and policies regarding exam make-ups.

11. *I don't understand what we're doing, and everything feels awful. How can things get better?* First, remember that no feeling lasts forever; second, don't make major decisions when you're feeling crummy. Start by looking at Section 6. Are you coming to class? Talking with me? Putting in a solid 9 hours of work per week? Try to articulate clearly to yourself and then to me how you're living your Math 4310 life, what your Math 4310 goals are, and what precisely is not right with your Math 4310 experience.

2. Contact Information

Instructor: Dr. Timothy Faver
Email: `tfaver1_AT_kennesaw.edu` (this is the best way to contact me)
Website: `https://tefaver.com/teaching/math-4310/`
Class time: MWF 11:15 am–12:05 pm
Class location: Mathematics Room D249
Office: Mathematics Room D248
Office hours: M 9:00 am–10:00 am, W 2:30 pm–3:30 pm

3. Learning Outcomes

Upon successfully completing this course, you will be able to do the following:

1. Define, perhaps inelegantly, what a partial differential equation (PDE) is and articulate, hopefully more elegantly, the importance of initial and boundary conditions in the mathematical analysis of PDE;

2. Derive a PDE and corresponding initial or boundary conditions from physical principles;

3. Deploy analytic techniques, such as separation of variables, Fourier series, and Fourier transforms, to solve PDE;

4. Analyze Sturm–Liouville equations and boundary value problems via eigenfunctions;

5. Appreciate the tension between linearity and nonlinearity in the analysis of PDE and how problems in PDE motivate techniques in real and infinite-dimensional linear analysis.

The following are all PDE for a function $u = u(x,t)$ of the two variables x and t, and they all look rather alike:

$$u_t+u_x=0, \quad u_t-u_x=0, \quad u_t-u_{xx}=0, \quad u_t+u_{xx}=0, \quad u_{tt}-u_{xx}=0, \quad \text{and} \quad u_{tt}+u_{xx}=0.$$

Remarkably, their mathematical analysis is (almost) completely different. The first two equations really are the same, and the third and fourth are, too (in that if you know how to solve one equation in the pair, you know how to solve the other). But the behavior of solutions to these two pairs are radically distinct, and then the fifth and sixth equations have yet other different properties from the preceding two groups. The presence or absence of a t- or x-derivative, and the placement of a $\pm$-sign, have profound consequences.

There probably is no general theory of PDE but rather many separate cases and examples—contrast that with the sharp existence and uniqueness theory for ordinary differential equations (ODE) at various levels. This is in significant part because *dimension* plays much more of a role in PDE than ODE, for now the independent variables are (at least) two-dimensional. We must contend with more *data*—and more *geometry*—in PDE than in ODE.

We will meet these challenges by keeping our expectations low and our standards high. We will focus primarily on the small, but representative, group of *linear* PDE displayed above, and we will develop extensively and thoroughly the mathematical tools needed to analyze, and sometimes solve, these equations. Chief among them will be the integral—*the* tool for extracting data about functions and representing functions.

4. Course Materials

1. We will follow the book ***Basic Partial Differential Equations*** by David Bleecker and George Csordas, but we will do so in a highly nonlinear fashion. (This is ironic, since most of our PDE will be linear.) You should be prepared to jump around a lot in the book, and so you should consult the daily log (below) quite often.

2. I will keep a **daily log** for our classes and post it on the course website. The log will contain corresponding reading from the textbook, a detailed (and idiosyncratic) discussion of what we cover in class each day, and a variety of problems, many of which I will assign and most of which you should attempt.

3. D2L will contain two **solutions manuals**, which I will regularly update: one for assigned problems from the textbook and one for assigned problems from the daily log. Solutions will appear in the order that problems appear from these sources, not necessarily in the order that I assign the problems. I will typically not provide solutions for problems that I do not explicitly assign, though you are welcome to ask me about them.

4. Here are some *prohibited* materials. Please remove AirPods and other listening devices during class. Please keep phones off your desks, and please do not take pictures of the board without my explicit permission.

5. Grading

Your final numerical grade will be based on weekly problem sets, a project, two in-class exams during the semester, and a final exam, all weighted as follows.

Problem Sets	35%
Portfolio Project	15%
Lowest exam score	10%
Higher two exam scores	20% each

The interval to which your final numerical grade belongs determines your final letter grade.

Numerical grade	**[90,100]**	**[80,90)**	**[70,80)**	**[60,70)**	**[0,60)**
Letter grade	A	B	C	D	F

5.1. Attendance. *Regular and engaged attendance is essential for your learning; failures in my classes are strongly correlated with low attendance or attendance with weak engagement.* I will take attendance on each of the days that we meet and do not have an exam. While attendance will not count numerically toward your final grade, it is all but impossible to pass the class without regular *and engaged* attendance. If you stop coming to class and do not submit work at some date past the withdrawal deadline, I will score missing work as 0 and compute your final grade from that; it is therefore highly likely that you will fail the class.

5.2. Problem sets (35%). *Regular work on weekly problem sets will strengthen your understanding of concepts and techniques and extend your awareness of course concepts beyond the scope of class meetings. Success in this class will be impossible without diligent, thorough*

completion of the problem sets. There will be 12 problem sets assigned on Fridays at 11:59 pm on the following Fridays; see the calendar (Section 8).

5.2.1. Preparation of problem sets. You will submit your solutions to the appropriate slot on D2L, and it is your responsibility to ensure that your D2L submissions are correctly formatted and organized according to the submission instructions. The goal of these stringent formatting requirements (to be repeated/expanded in individual assignment instructions) is twofold. First, I want your work to be as easy for you to revisit and parse as possible, and part of that is making sure your work is clearly organized and formatted. Second, I want your work to be easy for to review so that you get appropriate credit and so that I am sure you are doing the work that is meant to strengthen you.

5.2.2. The complete sentence requirement. Beginning with the third problem set, all solutions must be written using complete sentences, unless I explicitly allow otherwise in the problem set instructions. Examples of mathematical writing in complete sentences appear throughout the daily log and the textbook. Solutions that are not written in complete sentences will be scored 0, regardless of their mathematical correctness. We write to explain ourselves to others and to understand ourselves; clear and complete writing will facilitate everyone's understanding of your work.

5.2.3. Collaboration and consultation on problem sets. You are most welcome to consult with me throughout the week about the preparation of your problem sets; see Section 6.2 for advice on office hours and Section 6.3 for email policy. While you are welcome and encouraged to discuss problems with other students, your final work must be your own; you should write the final version of your solutions by yourself, without consulting others.

5.2.4. Grading of problem sets. I will drop your lowest 3 problem set scores, so that the problem set component of your final grade will be the average of your 9 best problem set scores. I will grade some problems for correctness and the rest for completeness. Problems graded for correctness will be scored from 0 to 5 points, with 0 points for no work, 5 points for essentially complete and correct work, and, in general, a 1-point deduction for each serious error. Problems graded for completeness will be scored from 0 to 2 points, with 0 points for no work, 2 points for complete work, and 1 point for work that, in my professional opinion, falls short of completeness. If solutions to the same problem from two or more people are suspiciously similar, I may score that problem 0 among all similar submissions.

5.2.5. The pushback option. You may push back three assignments from their Friday due date until the following Monday. For example, if you wish to push Problem Set 1 back, you would have until Monday, January 20, at 11:59 pm to submit it. You do not need to provide any reason for a pushback. However, you must request a pushback no later than 5 pm on the Thursday before the assignment is due. For example, if you wish to push Problem Set 1 back, you would have until Thursday, January 16, at 5 pm to tell me that you want to do so. The point of this condition is to ensure that you have started your assignment in a timely fashion and have been thinking about it throughout the week; leaving problem sets for Friday afternoons is dangerous and deleterious both for your learning and your peace of mind. Once you have used your three pushbacks, I will typically not allow any more, outside of exceptional circumstances at my discretion; once you have pushed a problem set back, I will not accept it late beyond the Monday deadline.

5.3. Project (15%). *You will submit a "portfolio" of 10 curated problems from the lecture notes and textbook that will take you beyond focused weekly problem sets and help you make connections across and beyond the course and develop your writing and presentation skills.* Full details of the portfolio project are on the course website; note that you will submit drafts of some problems along with exam reflections to keep you on track. See the course calendar (Section 8) for the portfolio due date and reminders about exam reflections.

5.4. Exams (50%). *Exam preparation will help you connect discrete course topics; completing an exam under time constraints is one way of evaluating your fluency with course material and your intellectual independence.* There will be two in-class exams (Exams 1 and 2) during the term and a cumulative final exam. The final exam will only be given at the university-specified time, which cannot be changed. See the calendar (Section 8).

5.4.1. Exam information documents and reflections. I will provide a detailed document giving information about an exam's content at least a week in advance of each exam. You will earn 5 points on each exam from a reflection activity that you will do based on the study guide; you can earn the other 95 points on the actual exam.

5.4.2. Absences from exams. In order to be excused from an exam, you must (1) notify me before the start of the exam (or as soon after as the circumstances allow) and (2) provide official documentation (a doctor's note, a quarantine notice or proof of COVID test, a note from your employer, etc.) excusing your absence in a timely manner. An absence may or may not be "excused." Important family commitments, religious obligations, feeling ill, COVID exposure/infection, emergency car trouble, legal issues, an essential work commitment, and university-sponsored athletics, trips, or programs are all sufficient reasons for an excused absence. Making up work in another class, oversleeping, traffic, and vacations (...early spring break...) are not. If your absence from an exam is excused, then you will take a make-up exam either before I return graded exams to the class, or, if that is not possible, during the final exam conflict period (see the calendar in Section 8); if your absence is not excused, you will score a 0 on that exam. In general, I will not permit a make-up if you notify me of your absence *after* the class has taken exam, barring exceptional circumstances that make prior communication absolutely impossible.

In the (hopefully) unlikely event that you first have an excused absence from Exam 1 and later have an excused absence from Exam 2, then you will take a make-up for Exam 2 within one week of returning to class. Failure to do so will result in a score of 0 on Exam 2. This is to prevent you from having too much work at the end of the term.

5.5. SDS accommodations. Please discuss any accommodations with me promptly at the start of the term. If you want to use extended time accommodations via SDS, you must make an appointment with SDS for them to proctor the exam.

5.6. Midterm grades. I will submit midterm grades by March 21 to help you assess your progress in the course. Your midterm numerical grade will be determined by the following breakdown:

$$50\% \text{ problem sets} + 50\% \text{ Exam 1}.$$

I will not drop any problem sets here. Note that the weights here are, overall, quite different from what will determine your final grade; a good midterm grade is not a promise of a good final grade, but a bad midterm grade should serve as a warning that something is amiss

in your current approach to the course. Midterm letter grades will follow the numerical correspondence for your final grade.

5.7. Incomplete grades. The catalogue specifies that an "incomplete grade may be awarded only when the student was doing satisfactory work prior to the last two weeks of the semester but for nonacademic reasons beyond the student's control, was unable to meet the full requirements of the course." I define "satisfactory work" to mean that you can obtain a score on your remaining work that will allow you to pass the class.

The catalog subsequently states that a "grade of 'I' must be removed by completing the course requirements within one calendar year from the end of the semester in which the 'I' was originally assigned. In addition, should the student enroll in classes at KSU during the calendar year, the grade of 'I' must be removed by the end of the first semester of enrollment during that calendar year."

If you are awarded an incomplete for this course, it will be to your advantage to complete all remaining work as soon as possible. Based on your circumstances, we will agree on a mutually convenient and appropriate timeline for completing your work. Failure to follow this timeline without a justifiable excuse may result in failing grades for the missed work and possibly the course. Ideally, you would complete all work by the end of May 2025.

6. Strategies for Success and/or Failure

6.1. Attendance and participation. Failures in my classes are strongly correlated with low attendance *or* attendance with minimal engagement; students who both attend class regularly and engage with me in and/or outside class tend to succeed.

6.2. Office hours. During office hours, we can discuss specific examples, problems, or techniques from class, the daily log, or the textbook. More broadly, we can talk about your study habits, time management, and mathematical reading skills. Before coming to office hours, think carefully about what you want to discuss so that we use our time well.

If my office hours conflict with your other classes, we can make an appointment for a different time. If the currently scheduled office hours conflict with the availability of students who most frequently want to see me, I may change the weekly hours to accommodate the preferences of the majority. If you would like to meet virtually, please let me know in advance, and I will send a Teams link.

6.3. Email communication. You are welcome to email me questions about any aspect of the course at any time. Feel free to send a photo or scan of work and indicate where you're stuck. A short hint from me can make a big difference for you.

I will (typically) respond to email within 24 hours, but I cannot guarantee a response to questions about problem sets or exams late on Thursday evenings. Those final hours before an exam or quiz need to be about perfecting what is already good in you, not about learning it for the first time.

Please observe the following courtesies in writing emails.

1. Please include the words "Math 4310" in the subject of your email. I filter emails and may not respond to your message promptly, or may miss it entirely, without these key words.

2. Please use your "students" email, not D2L email. I will not respond to messages sent

from D2L.

3. Please begin your email with a salutation (e.g., "Hi, Dr. Faver") before the body of text; this is simply good manners (and will put me in a good mood, which will be helpful for you). Please also address me by my name ("Dr. Faver," not just "Professor").

6.4. Workload breakdown. In general, it is reasonable (and usually necessary) for you to spend about three hours per credit hour outside of class on work for a course. Since our course is 3 credits, you should spend about 9 hours per week on your coursework. Here is a recommended arrangement of your worktimes for this class for weeks when a problem set is due, which will be most weeks.

1–2 hours: *active (re)reading of class notes and the daily log and selections from textbook (see the daily log).* I define "*active* reading" to mean reading each and every word (possibly *aloud*—this always helps me), clarifying any unknown word or phrase, and redoing each calculation or argument with pen and paper. Since, presumably, you have been actively engaged in class, your active (re)reading of class notes and the daily log should not take too much time. Instead, I expect that you will be patching up gaps from class, working through the examples from the textbook (which will typically differ from what we do in class), and embedding vocabulary, examples, and nonexamples into your memory for regular deployment.

3–4 hours: *working on required problem sets and recommended problems.* These are the problems assigned from the daily log and the textbook that I will grade, as well as recommended problems from the textbook (listed in the problem sets) and all problems marked (!) in the daily log. I expect you to do whatever you need to in order to understand every step of the solution to every problem. This timeframe by no means expects that you are spending 3 to 4 hours in isolated contemplation of the required problems. I expect that you are rereading (yet again) relevant sections of the daily log and textbook, discussing your work with classmates, and consulting me once you have made some independent progress.

1–2 hours: *writing up your solutions to the weekly problem set for submission.* This really means *rewriting* your initial work. The first thing that you write down when working on a problem should not be what you submit! Reread Sections 5.2.1 and 5.2.2.

∼1 hour: *working on portfolio problems.* Each week should provide several candidates for portfolio problems from the daily log and textbook; some weeks will have more than others. As you find problems interesting and meaningful, you should attempt them. Eventually you will need to spend more than 1 hour per week on the portfolio; this is the *minimum* amount of attention that you should give it.

This scheme will vary from week to week and person to person, but it will be to your benefit to spread these activities out throughout the week. You should have at least 6 hours of work per week, but there will probably be weeks during which you are able to do all of the above without taking 9 hours. Treasure those weeks! Those are good times to patch up your understanding of prior vocabulary, notation, and concepts and sticky points from class

or problem sets that you never resolved to your satisfaction and also to work more intensely on the portfolio project.

6.5. How to fail. The following strategies have helped prior students fail my classes.

1. Don't come to class regularly; in particular, show up only for exams.

2. Be physically present but intellectually disengaged in class. Avoid talking with me.

3. Don't do the problem sets or any recommended practice problems.

4. Save all your Math 4310 work for only one day each week, preferably the day before assignments are due.

5. Ask for, but then completely ignore, my advice on improving your course performance.

6. Fail the first exam and make absolutely no changes in your life after that.

7. Don't internalize any idiosyncratic vocabulary or notation. Do problems without knowing what the words and symbols in them mean!

8. Think about the course as an obstacle, not an opportunity. Definitely don't look for beauty, surprises, or things that might fill you with wonder and curiosity.

7. University Policies and Formal Matters

7.1. Federal, BOR, and KSU Student Policies. You should be familiar with the policies detailed via the links below, including the academic integrity statement.

`https://www.kennesaw.edu/curriculum-instruction-assessment/academic-program-planning-development/resources/required-syllabus-information.php`

7.2. Course catalogue description.
3 Credit Hours
Prerequisite: MATH 2203 and MATH 2306.
This course is an introduction to partial differential equations (PDEs), their applications in the sciences and the techniques that have proved useful in analyzing them. The techniques include separation of variables, Fourier series and Fourier transforms, orthogonal functions and eigenfunction expansions, Bessel functions, and Legendre polynomials. The student will see how the sciences motivate the formulation of partial differential equations as well as the formulation of boundary conditions and initial conditions. Parabolic, hyperbolic, and elliptic PDEs will be studied.

8. Calendar

You are responsible for knowing all of the due dates for assignments and scheduled dates for exams listed below. All submissions to D2L are due at 11:59 pm on the stated day. If class is canceled on the day of an exam, we will take that exam during our next meeting, unless I specify otherwise.

F January 17	Problem Set 1 due on D2L
M January 20	No class—Dr. Martin Luther King, Jr. Day
F January 24	Problem Set 2 due on D2L
F January 31	Problem Set 3 due on D2L
F February 7	Problem Set 4 due on D2L
M February 10	Exam 1 reflection due on D2L
F February 14	Exam 1 in class
F February 21	Problem Set 5 due on D2L
F February 28	Problem Set 6 due on D2L
F March 7	Problem Set 7 due on D2L
M–F March 10–14	No class—Spring Break
F March 21	Problem Set 8 due on D2L
M March 24	Exam 2 reflection due on D2L
F March 28	Exam 2 in class and Deadline to withdraw (11:45 pm)
F April 4	Problem Set 9 due on D2L
F April 11	Problem Set 10 due on D2L
F April 18	Problem Set 11 due on D2L
F April 25	Problem Set 12 and Final exam reflection due on D2L
M April 28	Last day of class and Portfolio project due on D2L
W April 30	Final exam 10:30 am–12:30 pm
R May 1	Exam makeups 10:30 am–11:30 am