

Math 6420: Partial Differential Equations

Spring 2022

January 4, 2022

INSTRUCTOR DETAILS

Instructor: William Feldman (he/him/his)

Office: JWB 101

Office Phone: (801) 581-4279 (better use email or Zoom)

Email: feldman@math.utah.edu

Webpage: http://www.math.utah.edu/~feldman/MATH_6420_S22.html

Zoom room: see canvas

Office Hours: TBA, will be held in Zoom room listed above. I hope to transition to in person office hours later in the semester.

Accessibility and Support: Email is the best way to reach me, I will respond as promptly as I can, but generally expect to receive a response during "business hours". You can also set up a time to meet with me on Zoom or in person at my office.

TA DETAILS

The course also has a graduate TA / grader. Details TBA.

COURSE DETAILS

Course type: In person

Class time: MWF 11:50PM-12:40PM

Location: LCB 222

Webpage: http://math.utah.edu/~feldman/MATH_6420_S22.html

COVID note: If I am sick or if someone in the class tests positive for COVID we may need to hold some lectures on Zoom. Please be prepared for that possibility. Any lectures held on Zoom will be recorded. If you need to miss class for any COVID related reason but the lecture will not be on Zoom that day please let me know so I can prepare some kind of accommodation.

COURSE MATERIALS

Primary Textbook:

Partial Differential Equations, 2nd Edition, Lawrence C. Evans.

Additional course materials will be shared online via CANVAS.

COURSE DESCRIPTION

This is the second semester of a year long course on differential equations. This class will cover partial differential equations (PDE). I will provide / remind of most of the background materials needed for the course. *I would suggest reviewing your multi-variable calculus as it will become important very quickly in the course.* The appendix of Evans' textbook is a fine source for this.

Passing this course with an **A** grade will count as a high pass on the ODE qualifying exam, and passing with a **A**– or **B**+ will count as a pass. The course will also help you prepare for the ODE qualifying exam if you prefer to go that route or are unsatisfied with your grade in the course.

Topics (see also <http://www.math.utah.edu/dept/gradbull.pdf>)

- **The Laplace equation:** Harmonic functions, mean value theorems, maximum principles, energy minimization; Fundamental solution; Boundary value problems; Green's functions; Potential theory.
- **Diffusion:** The one-dimensional diffusion equation; Uniqueness: integral methods and maximum principles; Fundamental solution and the global Cauchy problem; Random walks; Global Cauchy problem, maximum principles; Energy methods; Some nonlinear problems: traveling waves.

- **Waves and vibrations:** General concepts, e.g., types of waves, group velocity, dispersion relations; One-dimensional wave equation, waves on a string; The D'Alembert formula and characteristics; Classification of second-order linear equations; Multi-dimensional wave equation, the Cauchy problem; Energy methods / uniqueness.
- **First order equations: Scalar conservation laws and Hamilton-Jacobi Equations:** Linear transport equation and conservation laws; Method of Characteristics; Weak solutions and shock waves; Entropy solutions; Hamilton-Jacobi Equations; Lagrangian-Hamiltonian duality; Control formulation and dynamic programming principle; viscosity solutions.
- **Variational formulation of elliptic problems:** Linear operators and duality; Lax–Milgram theorem and minimization of bilinear forms; Galerkin method; Variational formulation of Poisson's equation in 1D; Variational formulation of Poisson's equation in higher dimensions.

IMPORTANT DATES

Exams: Final exam date is Wednesday, May 4, 2022 at 10:30 am – 12:30 pm.

University calendar: <https://registrar.utah.edu/academic-calendars/spring2022.php>

Holidays:

- MLK Day (Monday, Jan 17)
- Presidents Day (Monday Feb 21)
- Spring break (Sun-Sun March 6-13)

GRADING POLICY

- Calculation of final grade:
 - **40%** - Homework
 - **20%** - Midterm Exam - There will be an in-class hour exam on Wednesday, March 2 (subject to change at instructors discretion with reasonable notice).

- **40%** - Final Exam - The final exam is on Wednesday, May 4, 2022 at 10:30 am – 12:30 pm.
- Your final letter grade will be determined by the following rubric:
 - **A** : 90%+
 - **A-** : 85%-90%
 - **B+** : 80%-85%
 - **B** : 70% - 80%
 - **C** : below

Note that, as per the department's [graduate bulletin](#) an **A** in the course counts as a high pass on the ODE qualifier, and an **A-** or **B+** counts as a pass on the ODE qualifier.

- Double check the accuracy of all recorded homework, online assignments, and exam grades. Also you should keep as record all your graded assignments. If you see any error in your grades on Canvas/Gradescope, reach out to me as soon as possible.

HOMEWORK

Homework is the most important part of this course. The problems will likely be quite challenging, it is important to devote sufficient time to thinking about and writing your homework assignments.

Homework problems will be assigned individually, approximately 3-5 problems per week. Problems will be due one week after they are assigned. You should turn in your solutions via gradescope. LaTeX or hand written and scanned solutions are both acceptable. Due dates are semi-flexible, but if you turn in your homework after that problem has already been graded without an excuse you may be subject to a 30% penalty to your grade on that problem. The lowest 15% of problem grades will be dropped at the end of the semester.

LATE ASSIGNMENTS/MISSED ASSIGNMENTS/REGRADING POLICIES

- Homework assignments will not be considered late until 11:59pm on the day they are due. If you need an extension let me know, but this option should be used sparingly and with good reason.

- Regrades: If you notice a mistake in grading you can return your assignment/quiz/test to me to be regraded. You should submit the assignment in question along with a note explaining where you believe the grading error was.

COVID related details

University leadership has urged all faculty, students, and staff to **model the vaccination, testing, and masking behaviors** we want to see in our campus community.

These include:

- Vaccination
- Masking indoors
- If unvaccinated, getting weekly asymptomatic coronavirus testing

Vaccination:

- Get a COVID-19 vaccination if you have not already done so. Vaccination is proving highly effective in preventing severe COVID-19 symptoms, hospitalization and death from coronavirus. Vaccination is the single best way to stop this COVID resurgence in its tracks.
- Many in the campus community already have gotten vaccinated:
 - More than 80 percent of U. employees
 - Over 70 percent of U. students
- Visit <http://mychart.med.utah.edu/>, <http://alert.utah.edu/covid/vaccine>, or <http://vaccines.gov/> to schedule your vaccination.

Masking:

- While masks are no longer required outside of Health Sciences facilities, UTA buses and campus shuttles, CDC guidelines now call for everyone to wear face masks indoors.
- Check the CDC website periodically for masking updates— <https://www.cdc.gov/coronavirus/2019-ncov/vaccines/fully-vaccinatedguidance.html>

- Treat masks like seasonal clothing (i.e. during community surges in COVID transmission, masks are strongly encouraged indoors and in close groups outside).

Testing

- If you are not yet vaccinated, get weekly asymptomatic coronavirus tests. This is a helpful way to protect yourself and those around you because asymptomatic individuals can unknowingly spread the coronavirus to others.
- Asymptomatic testing centers are open and convenient: Online scheduling Saliva test (no nasal swabs) Free to all students returning to campus (required for students in University housing) Results often within 24 hours Visit alert.utah.edu/covid/testing
- Remember: Students must self-report if they test positive for COVID-19 via this website: <https://coronavirus.utah.edu/>.