Instructor

Prof. Matthew Pennybacker. My office is SMLC 226. For most matters, please contact me by email at `pennybacker@unm.edu`.

Overview

This is a first graduate course in partial differential equations. We will cover the following topics.

- Derivation of elementary PDEs from physical problems: the heat, wave, and Laplace equations. Elementary solution techniques for PDEs. Method of separation of variables and transform methods. Fourier series and integrals. Physical applications.
- First order quasilinear and nonlinear PDEs. The method of characteristics. Existence and uniqueness of solutions. The Cauchy-Kowalevski theorem.
- Hyperbolic equations. The wave equation in 1-D and Multi-D. D'Alambert's solution. Solution of mixed initial-boundary value problems. The method of reflection. Propagation of singularities. The energy principle.
- Elliptic equations. Laplace and Poisson equations. Fundamental solutions and Green's functions. The Dirichlet and Neumann problems. Elementary properties of harmonic functions. Maximum principle. Potential theory. Variational formulations.
- Parabolic equations. The heat equation. Fundamental solutions. Solution of the initial value problem. Solution of mixed initial-boundary value problems. The method of reflection. Duhamel's principle. Elementary properties of solutions of the heat equation. Maximum principles.
- Current topics in PDEs as time permits.

The second edition of *Partial Differential Equations* by Lawrence C. Evans is required.

Homework

Homework is an important part of this course. **Late homework will not be accepted** unless there are exceptional circumstances. Please contact me as soon as possible if this is the case. You are encouraged to work with each other on the homework, as well as make use of office hours, but **you must hand in all solutions in your own handwriting and your own words**.

Grading

The final grade will be calculated as a fraction of 100 possible points. Homework will comprise 50 points, a midterm exam 20 points, and a final exam 30 points. Passing grades will be assigned using the following point ranges.

A: 90 – 100, B: 80 – 90, C: 70 – 80, D: 60 – 70.

Communication

Please check your UNM email regularly or make sure to forward your email from that address to an account that you check at least once daily during the week. Email is the easiest way for me to communicate important information to the entire class. For the most current information about the syllabus, quizzes, and homework, you can visit the course webpage. Do not hesitate to contact me if you have any questions or you experience any difficulties that may affect your progress during the course.

Accommodations

In accordance with University Policy 2310 and the American Disabilities Act (ADA), academic accommodations may be made for any student who notifies the instructor of the need for an accommodation. It is imperative that you take the initiative to bring such needs to the instructor's attention, as the instructor is not legally permitted to inquire. Students who may require assistance in emergency evacuations should contact the instructor as to the most appropriate procedures to follow. Please contact Accessibility Services at 505-661-4692 for additional information.

Sexual Misconduct

In an effort to meet obligations under Title IX, UNM faculty, Teaching Assistants, and Graduate Assistants are considered "responsible employees" by the Department of Education (see page 15 of `http://www2.ed.gov/about/offices/list/ocr/docs/qa-201404-title-ix.pdf`). This designation requires that any report of gender discrimination which includes sexual harassment, sexual misconduct and sexual violence made to a faculty member, TA, or GA must be reported to the Title IX Coordinator at the Office of Equal Opportunity (`oeo.unm.edu`). For more information on the campus policy regarding sexual misconduct, see `https://policy.unm.edu/university-policies/2000/2740.html`.

Tentative Schedule

Week	Dates	Reading	Topics
1	Jan 17, 19	1.1 – 1.4, 2.1	Introduction. Transport equation.
2	Jan 24, 26	2.2.1, 2.2.2	Fundamental solution for Laplace's and Poisson's equations. Mean-value formulas.
3	Jan 31, Feb 2	2.2.3	Properties of harmonic functions.
4	Feb 7, 9	2.2.4, 2.2.5	Green's functions for Poisson's equation. Energy methods.
5	Feb 14, 16	2.3.1, 2.3.2	Fundamental solution for the heat equation. Mean-value formula.
6	Feb 21, 23	2.3.3	Properties of solutions for the heat equation.
7	Feb 28, Mar 2	2.3.4	Energy methods for the heat equation. Midterm exam.
8	Mar 7, 9		**Spring Break**
9	Mar 14, 16	2.4.1	Spherical means formulas for the wave equation.
10	Mar 21, 23	2.4.2, 3.1	Energy methods for the wave equation. Complete integrals and envelopes.
11	Mar 28, 30	3.2	Method of characteristics.
12	Apr 4, 6	3.3	Hamilton-Jacobi equations.
13	Apr 11, 13	3.4	Conservation laws.
14	Apr 18, 20	4.1	Separation of variables.
15	Apr 25, 27	4.3.1	Fourier transform.
16	May 2, 4	4.3.2	Laplace transform.