Instructor

Prof. Matthew Pennybacker. My office is SMLC 226. For most matters, please contact me by email at `pennybacker@math.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 textbook *Partial Differential Equations* by Fritz John is required. Other texts that may be helpful are *Partial Differential Equations* by Lawrence C. Evans and *Partial Differential Equations: Methods and Applications* by Robert C. McOwen.

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 70 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.

Tentative Schedule

Week	Dates	Reading	Topics
1	Jan 19, 21	1.1 – 1.6	The single first-order equation.
2	Jan 26, 28	1.7 – 1.9	The single first-order equation, continued.
3	Feb 2, 4	2.1 – 2.6	Second-order equations.
4	Feb 9, 11	3.1, 3.2	Characteristic manifolds and the Cauchy problem.
5	Feb 16, 18	3.3	The Cauchy-Kowalevski theorem.
6	Feb 23, 25	4.1, 4.2	The Laplace equation.
7	Mar 1, 3	4.3 – 4.5	The Laplace equation, continued.
8	Mar 8, 10	5.1	Hyperbolic equations in 1-D.
9	Mar 15, 17		Spring Break.
10	Mar 22, 24	5.2	Hyperbolic equations in Multi-D.
11	Mar 29, 31	5.3	Hyperbolic equations in Multi-D, continued.
12	Apr 5, 7	6.1, 6.2	Higher order elliptic equations.
13	Apr 12, 14	7.1	Parabolic equations.
14	Apr 19, 21	7.2	Parabolic equations, continued.
15	Apr 26, 28		Catch-up.
16	May 3, 5		Current topics in PDEs.