Math 126: Partial differential equations

ORC syllabus

Partial differential equations play critical roles in wide areas of mathematics, science, and engineering. This is an introductory course, accessible to undergraduate and graduate students in mathematics and other scientific disciplines who have completed the prerequisites. Examples will come from both linear and non-linear partial differential equations, including the wave equation, diffusion, boundary value problems, conservation laws, and the Monge-Ampere equations.

References.

[S] W. A. Strauss, *Partial differential equations: an introduction*, Wiley, 2nd ed., 2007. [main text].

[E] L. C. Evans, *Partial differential equations*, Amer. Math. Soc., 2nd ed., 2010. [supplemental text].

[L] J. David Logan, *Applied mathematics*, John Wiley & Sons, 3rd ed., 2006. [supplemental text].

[S] Vladimir I. Arnold and Roger Cooke, *Lectures on partial differential equations*, Springer, 2004. [advanced text].

Partial differential equations.

1. Introduction: PDE modeling, review of ODEs especially series solutions.

2. Classification: first-order equations, initial and boundary conditions, well-posed problems, types of second-order equations.

3. Wave equations: vibrations of a drum, causality and energy, reflections of waves, waves with a source.

4. Diffusion equations: diffusion on the whole line, the half line, diffusion with a source.

5. Boundary value problems: separation of variables, boundary conditions, Fourier transforms, orthogonality and completeness, Laplace and Poisson equations.

6. Eigenvalue problems: computation of eigenvalues, symmetric differential operators, asymptotics of eigenvalues.

7. Distributions and weak formulation: weak solutions, FEM, distributions, Green's functions.

8. Function spaces: Hilbert space, Lax-Milgram theorem, Banach space.

9. Abstract formulation: second-order elliptic equations, second-order linear evolution equations, semigroup theory.

10. Other topics as time allows.