

# APM 351: Differential Equations in Mathematical Physics

## Announcement of Midterm Test

### When and where?

Monday, November 4 2011, 5-7pm, in Galbraith 304  
Closed books, closed notes.

### Topics

The test will cover Chapters 1-4 and Sections 5.1-3 of Strauss, and Assignments 1-7. Specifically:

- *What is a PDE?* What is a solution? Classification: Linear, quasilinear, fully nonlinear equations. Differential operators and superposition. Initial and boundary values. Well-posed problems.
- *First-order linear equations.* The method of characteristics. Existence and uniqueness. The transversality condition.
- *Second-order linear PDE.* Elliptic, parabolic, and hyperbolic equations. How to factor a hyperbolic differential operator; canonical (characteristic) coordinates.
- *The wave equation on the real line.* The general form of the solution; D'Alembert's formula. Causality and energy; finite speed of propagation, domain of dependence, domain of influence.
- *The heat equation on the real line.* The fundamental solution. Maximum principle and energy methods. Infinite speed of propagation. The light cone; domain of dependence, domain of influence.
- *Reflections and sources.* Solving boundary-value problems by even and odd reflection. Inhomogeneous equations; the Duhamel principle.
- *Separation of variables.* Boundary-value problems for the wave and heat equation. Dirichlet, Neumann, Robin, and periodic boundary conditions. Eigenvalues and eigenfunctions. Green's identity.
- *Fourier series.* Sine, cosine, and complex exponential series. How to compute the Fourier coefficients of a given function.  $L^2$ -inner product and orthogonality. Symmetric boundary conditions and self-adjointness of  $-\partial_x^2$ .