MATH 732 : PARTIAL DIFFERENTIAL EQUATIONS I
Fall 2008

Instructor: Dejan Slepčev
Course webpage: Will be available through CMU Blackboard
Lectures MWF 9:30 in PPB 300 (CNA Seminar room)
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Text: *Partial Differential Equations*, by Lawrence C. Evans, AMS 2002.

Description. Partial differential equation are used to model a vast variety of phenomena. The aim of this course is to familiarize one with different types of differential equations and their basic properties. The prerequisite for the course is solid knowledge of multidimensional calculus and matrix algebra. Familiarity with concepts of real analysis and having taken an undergraduate PDE course are helpful but not necessary. While the course focuses on understanding, most of the statements made will be proven rigorously. Mathematical rigor is expected of the problem set solutions as well. Basic methods for solving the equations numerically will also be discussed.

Evaluation. The course grade will be based on problem sets (50%), a midterm exam (20%), and a final exam (30%). Midterm exam will be 3 hours long; time and date will be arranged. It will be a closed book exam, however everyone is welcome to bring one (two sided) letter-sized sheet of notes.

Problem sets. There will be 6 problem sets. The problem sets and due dates will be posted on the course Blackboard page. Late homework will not receive score. However, if you have a valid reason for not doing a problem set (illness for example), the particular homework will not count towards your grade.
Discussing the problem sets with your classmates is fine, as long as you are only exchanging ideas and general knowledge, and not the solutions to the problems. In particular everyone should present his/her own solutions.

OUTLINE

I. **Linear PDE**

1. Transport equation
2. Laplace's equation

   fundamental solution, mean value property, Green's function, energy estimates, maximum principle, uniqueness, regularity, Fourier series, solving boundary-value problems numerically

3. Heat equation

   fundamental solution, mean value property, Duhamel's principle, energy estimates, maximum principle, uniqueness, regularity, discretization, and numerical methods

4. Wave equation

   spherical means, Duhamel's principle, energy methods, uniqueness

II. **Nonlinear first order PDE**

1. Method of characteristics
2. Hamilton-Jacobi equations
3. Conservation laws

   the need for and the notion of a weak solution, shocks, rarefaction waves, Rankine–Hugoniot condition, entropy conditions, existence and uniqueness of weak solutions

III. **Further topics**

1. Variational principles
2. Numerical methods for first order equations
3. Dimensional analysis, similarity and scaling