Basic Theory of Partial Differential Equations
Math 275
Spring 2016

Instructor: William Feldman
Office: Ryerson 360-A
Email: feldman@math.uchicago.edu
Course Webpage: www.math.uchicago.edu/~feldman/teaching.html

Class: TR 10:30AM-11:50AM, Eckhart 206
Office Hours: M 2:30-3:30pm, T 4-5pm

College Fellow: Seung uk Jang
Problem Session: W 6-7pm, Eckhart 308

Text: *Partial Differential Equations: An Introduction to Theory and Applications*, Michael Shearer and Rachel Levy.
Additional Sources (optional): *Partial Differential Equations*, Lawrence C. Evans.

General Policy: There will be one in-class midterm and a final exam. Homework will be assigned weekly on Thursday and due the next Thursday in class. Late homework will not be accepted. You may of course collaborate on the homework assignments, but you should write up the solutions independently. The coursework will be weighted as follows in the final grade:

Midterm: 30%
Final Exam: 40%
Homework: 30%

Important dates:
Midterm: In class on Tuesday, April 26.
Final Exam: Tuesday June 7, 10:30AM-12:30PM.

Important Notice:

It is the policy of the Department of Mathematics that the following rules apply to final exams in all undergraduate mathematics courses:

1. *The final exam must occur at the time and place designated on the College Final Exam Schedule.* In particular, *no* final examinations may be given during the tenth week of the quarter, except in the case of graduating seniors.
2. Instructiors are not permitted to excuse students from the scheduled time of the final exam except in the cases of an Incomplete.

Tentative Course Outline:

- Overview of PDE, basic examples
- Motivation of wave, Laplace, and heat equations
- Transport equation
- Laplace equation
  - Fundamental solution
  - Solving Poisson's equation with the fundamental solution
  - Boundary value problems: Dirichlet and Neumann
  - Mean value property
  - Strong maximum principle and uniqueness
  - Energy method
  - Regularity of harmonic functions

  - Liouville's Theorem
  - Green's functions, Poisson kernels
  - Perron's method
  - Barrier method for boundary continuity
  - Finite difference schemes, discrete Laplacian
  - Connection with simple random walk and Brownian motion
- Separation of Variables
- Heat Equation
  - Heat kernel
  - Solution to initial value problem in whole space
  - inhomogeneous problem: Duhamel formula
  - Maximum principle
  - Uniqueness of Dirichlet problem
  - Energy dissipation
  - Connection with simple random walk and Brownian motion
  - finite difference schemes
- Wave Equation
  - Wave equation in $d = 1$, boundary value problems
  - Finite speed of propagation, cone of dependence, uniqueness
  - Duhamel method for non-homogeneous problems
  - Solution in $\mathbb{R}^3$ and $\mathbb{R}^2$, difference between even and odd dimensions
- First order equations: method of characteristics
- Burger's Equation, Conservation Laws
- Possible topics at the end of the course
  - Fisher-KPP Equation
  - Porous Medium Equation
  - Hamilton Jacobi Equations