TuTh 2:00pm - 3:15pm MTH MTH2300 (changed from 1311)
Instructor: M. Machedon
Office: MTH 3311
Office hours: Tuesdays 3:30 to 4:20
e-mail: mxm@math.umd.edu
Required text: Evans, Partial Differential Equations second edition

Recommended:
Zimmer, Essential results of functional analysis.
Wheeden and Zygmund, Measure and Integral (real analysis background).
and, for a modern point of view, Sergiu Klainerman’s notes available at

This is (or was) a "qualifying exam" course on theoretical methods in PDEs, emphasizing functional analysis based methods. The prerequisites for this course are math 673 (or equivalent), familiarity with real variables (Math 630) and mathematical maturity. Some familiarity with functional analysis would be very helpful, but we will cover all necessary functional analysis.

We will cover the following topics.
$W^{1,p}$ Sobolev spaces in a domain: Definition, density of extension, traces, embedding, Poincare’s inequality.
$H^s$ Sobolev spaces using the Fourier transform.
Lax-Milgram theorem. Variational solutions to elliptic equations
Elements of spectral theory for bounded self-adjoint operators: Definition of the spectrum, the case of compact operator (diagonalization, Fredholm alternative).
Weak topologies and the Hahn-Banach theorem (possibly without proofs)
Additional topics may include more on distribution theory, the Hardy-Littlewood-Sobolev inequality, introduction to Calderon-Zygmund theory for elliptic equations, introduction to Strichartz estimates for the Schrödinger equation.
There will be several problem sets. Some problems will be taken from old qualifying exams, available at http://www-math.umd.edu/quals.html

Grading: 30% homework, 40% two in-class exams (on chapters 5 and 6 in Evans), 30% final exam.

The in-class exams will be on Thursday, March 5 and Tuesday, April 14.

The final exam will be on Monday, May 18 from 10:30am to 12:30pm

Make-up policy: There will be no make-ups for the in-class exams. In the case of an absence due to illness, religious observance, participation in a University activity at the request of University authorities, or other compelling circumstances, your blank grade will be replaced by the average of your homework grade and the final exam grade, weighted equally.

No late homework will be accepted. Homework assignments missed due to valid reasons will be replaced by the average of the other homework grades.

The major grading events for this class are the in-class exams and the final.

On exams students must write by hand and sign the following pledge:
I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

Students who require special examination conditions must register with the office of the Disabled Students Services (DSS) in Shoemaker Hall. Documentation must be provided to the instructor. Proper forms must be filled and provided to the instructor before every exam.

The University’s policy on religious observance and classroom and tests states that students should not be penalized for participation in religious observances. Students are responsible for notifying the instructor of projected absences within the first two weeks of the semester. This is especially important for final examinations.

I will communicate with the class by e-mail. You can update your e-mail address at http://www.testudo.umd.edu/apps/saddr/

Problem set 1, due in late February, at a date to be determined.

Evans, Chapter 5: 4, 8, 9, 12, 13, 14, 15, 16

Qualifying exams:
August 2011, 4
Problem set 2, due Thursday, April 2.

Qualifying exams:
- August 13, 3, 4
- August 12, 5
- January 11, 5
- January 10, 5
- August 2005, 2

Also assigned is the following problem:

Let $B$ be the unit ball in $\mathbb{R}^2$, and $S$ its boundary.

a) Prove there exists a constant $C$ such that, for all $u$ smooth up to the boundary,

$$\int_B u^2 \, dx \, dy \leq C \left( \int_B |\nabla u|^2 \, dx \, dy + \int_S u^2 \, ds \right)$$

b) Find the weak formulation of the boundary value problem $-\Delta u = f$ in $B$, $u + u_n = 0$ on $S$, and prove that for every $f \in L^2$, this problem has a unique $H^1$ solution. Here $u_n = u_r$ is the normal derivative to the boundary.

c) Consider the related problem $-\Delta u = f$ in $B$, $u - u_n = 0$ on $S$. Show by an example, that this problem does not, in general have a unique solution.