MATH 674 (AMSC 674): Partial Differential Equations II
Department of Mathematics, UMCP **Spring 2010**
Handout 1: SYLLABUS AND POLICIES Tuesday, 01/26/10

Lecture Room: MATH 0304 **Time:** TuTh 9:30a.m.– 10:50a.m.

Instructor: Dio Margetis; e-mail: dio@math.umd.edu
Office: MATH 4416; telephone: (301)405-5455.

Office hours: Tuesdays 11a.m.-12:00noon; or by appointment. Since I am occasionally called away for research matters, it is advisable to check with me as to whether I will be in my office at the indicated hours.

Teaching Assistant (TA)/Grader: Mr. Xuwen Chen (chenxuwen@math). Office hour: Wed, 2-3pm, or by appointment.

Prerequisites: Practically, none. Typically, MATH/AMSC 673, or equivalent, or permission of the instructor. The course is largely self-contained. Some prior familiarity of students with functional analysis would be helpful but not required. Ask for instructor's permission if you are in doubt.
Note: A primary purpose of MATH/AMSC 674 is to prepare graduate students of the Mathematics Department for the PDE Qualifying Exam. Hence, most of the material for this course is well defined.

Text: The main textbook is L. C. Evans, Partial Differential Equations, AMS, 2002 (reprinted) or 2008; for a list of errata for this text see **note** in Handout 2 for MATH673. **Reading and a few homework problems will be assigned from this text.** A few other recommended texts as well as more specialized texts for further reading (listed in the suggested forthcoming bibliography for the course) will also be consulted or partly followed.

Course Web page: www.math.umd.edu/∼dio/courses/674/
All homeworks and practice problems will be posted at this website.

Grading policy: NO EXAMS OR TESTS. Grades will be based exclusively on 4-5 sets of homeworks. Each set will be due (usually) 2 or 3 weeks after it is handed out.

Once assigned, the homeworks must be turned in by the date specified. Your solutions are required to be *legible and clear.* You are encouraged *but not required* to prepare your homework sets by using a word processor. Illegible problems will not be graded.

Scope and topics: The course focuses on modern concepts and techniques of functional analysis for the solution of linear (primarily) and some nonlinear PDE. Two major theorems to be taught are the **Lax-Milgram theorem** and the **Fredholm alternative**, along with their applications in understanding solutions of a class of PDE. Emphasis will also be placed on (parabolic and hyperbolic) evolution equations. *Weak solutions*, which form a broad class of solutions needed in numerical methods and elsewhere, will be addressed.

(CONTINUED ON REVERSE)

Topics to be covered (mainly Chaps. 5-7 from Evans):

Introduction (some background). Banach and Hilbert spaces. Compact operators and applications. Sobolev spaces and weak derivatives. Sobolev and Poincaré's inequalities; compactness. Related Fourier transform methods. The space H^{-1}; gradient flows.

2nd-order elliptic PDE. The concept of weak solutions. Existence: Lax-Milgram theorem; Fredholm alternative; energy estimates. Regularity. Eigenvalues and eigenfunctions. Applications: Steady-state heat flow; evaporation-condensation in materials science; fluid mechanics; "can one hear the shape of a drum" ?

Linear evolution equations. 2nd-order parabolic PDE: Existence of weak solutions; regularity; maximum principles. Applications: diffusions; telegraph and beam equations; Fokker-Planck equations and connections to stochastic processes.

2nd-order hyperbolic PDE: Existence of weak solutions; regularity; speed of propagation. Applications: wave equations; scattering and diffraction of waves.

Introduction to semigroup theory. Elementary properties; contractions. Applications to parabolic and hyperbolic PDE.

Special topic: Theory of nonlinear dispersive PDE. If time permits: Some concept and techniques. The nonlinear Schrödinger equation (nonlinear optics, Bose-Einstein condensation); blowup of solutions. The KdV equation (water waves). The material will follow partly the text <u>Nonlinear dispersive equations: Local and global analysis</u>, by T. Tao.

Note on Academic Integrity. You are expected to read carefully and adhere to the following instruction provided by the Student Honor Council.

The University of Maryland, College Park has a nationally recognized Code of Academic Integrity, administered by the Student Honor Council. This Code sets standards for academic integrity at Maryland for all undergraduate and graduate students. As a student you are responsible for upholding these standards for this course. It is very important for you to be aware of the consequences of cheating, fabrication, facilitation, and plagiarism. For more information on the Code of Academic Integrity or the Student Honor Council, please visit http://www.shc.umd.edu.

To further exhibit your commitment to academic integrity, remember to sign the Honor Pledge on all assignments: *"I pledge on my honor that I have not given or received any unauthorized assistance on this assignment."*

Additional note for MATH 674: You will not be asked to sign such a pledge on possible homework assignments, but you are nevertheless expected to adhere to the principles of the pledge. The rationale for the pledge is available online at http://www.umd.edu/honorpledge.

Students With Disabilities. If you have a documented disability and need academic accommodations, please contact the instructor (me) as soon as possible.

Religious Observances. If you will be absent from class because of religious observances, please submit a list of the dates of your absences within a couple of days.