COURSE: MATH 950, FALL 2015

ADVANCED PARTIAL DIFFERENTIAL EQUATIONS

INSTRUCTOR: Prof. Milena Stanislavova

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TIME AND PLACE: MWF 10:00-10:50, 302 Snow

TEXT: Robert C. McOwen, Partial Differential Equations: Methods and Applications, second edition, Prentice Hall

PREREQUISITES: Math 320 or 321

CREDIT HOURS: 3

A graduate level course in Partial Differential Equations and their applications in mathematical physics. In the first part of the class we will cover the classical results in the theory including first order equations and the method of characteristics and higher order equations, mostly linear. Most of the time will be spend studying the 3 basic equations of mathematical physics-the wave, the heat and the Laplace equation, their existence and uniqueness theory and their properties. We will emphasize the connection to applied mathematics and will try to introduce some modern techniques whenever possible. In the second part we will use functional analysis and semigroups methods to introduce and study some nonlinear equations.

HOMEWORK: There will be five graded assignments for the semester and a final assignment, which will determine your grade.

TENTATIVE TOPICS

1. Introduction and connections with ODEs - exact methods for solving PDEs, special solutions.

2. First order equations, method of characteristics, conservation laws and jump conditions.

3. Principles for higher-order equations, Cauchy problems, classification by characteristics, canonical forms.

4. The wave equation-one dimensional initial-boundary value problem, two- and three-dimensional equation, Huygens principle. Energy methods, dispersion, dissipation terms, domain of dependence, applications to light and sound.

5. The Laplace equation-separation of variables, uniqueness, maximum principle, properties of harmonic functions, potential theory and Green's function. Existence theory-subharmonic functions and Perron's method. Eigenvalues of the Laplacian.

6. The heat equation in a bounded domain, maximum principle, uniqueness, fundamental solution. Regularity and similarity, application to fluid dynamics.

7. Semigroups and dynamics, applications to nonlinear PDE's.

ADDITIONAL SUGGESTED BOOKS:

1. Partial Differential Equations: Second Edition by Lawrence C. Evans

2. An introduction to Partial Differential Equations by Renardy and Rogers