MA495

PARTIAL DIFFERENTIAL EQUATIONS

Analytical and Numerical Methods with Applications

Partial differential equations (PDEs) are the fundamental models of mathematical physics, and, as such, are fundamental in engineering, economics, biomathematics, and other physical sciences. These equations model quantities that are changing with respect to spatial location, time, or both, and are called partial differential equations because the equations involve partial derivatives.

This course will provide a modern introduction to the most fundamental theoretical and numerical techniques for PDEs. We will study the most important elliptic, parabolic and hyperbolic PDEs, and we will discuss several different solution techniques. Although the classical techniques such as the method of Fourier series, the method of Green's functions, and the finite difference method will be studied, the main emphasis will be on a solid foundation of the (adaptive) finite element method which includes the discretization of the PDEs and the convergence analysis. Some important inverse problems emerging from real world problems modeled as PDEs will also be discussed. Physical applications include static phenomena in mechanics, heat flow and equilibrium, and wave motion. An integral part of the course will be using computer software (Maple or Matlab) together with the techniques learned in class to obtain useful solutions or numerical solutions.

Course Objectives: This course enables students to gain necessary knowledge of mathematical models leading to partial differential equations, and modern techniques that are currently available to solve, theoretically and numerically, the most relevant PDEs models. Since a working knowledge of PDEs is core not only for most applied and industrial mathematics courses but also in other disciplines such as mathematical physics and financial marketing, the present course is among the most useful courses in Applied and Industrial Mathematics.

Prerequisite: Differential Equations or Calculus III.
Instructor: Dr. Akhtar A. Khan