PARTIAL DIFFERENTIAL EQUATIONS

An Introduction with *Mathematica* and Maple

(Annotation of a New Book)

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From the Preface: "This textbook is a self-contained introduction to Partial Differential Equations (PDEs). It is designed for undergraduate and first year graduate students in mathematics, physics, engineering or, in general, science majors.

The goal is to give an introduction to the basic equations of mathematical physics and the properties of their solutions, based on the classical calculus and ordinary differential equations. Advanced concepts such as weak solutions and discontinuous solutions of nonlinear conservation laws are also considered. Although much of the material contained in this book can be found in the standard textbooks, the treatment here is reduced to the following features:

- To consider first and second order linear classical PDEs, as well as to present some ideas for nonlinear equations.
- To give explicit formulae and derive properties of solutions for problems with homogeneous and inhomogeneous equations; without boundaries and with boundaries. To consider the one dimensional spatial case before going on to two and three dimensional cases.
- To illustrate the effects for different problems with model examples: To use Mathematics software products as *Mathematica* and MAPLE in ScientifiCWorkPlacE in both graphical and computational aspects.

In Chapter I we present the theory of first-order PDEs, linear, quasilinear, nonlinear, the method of characteristics and the Cauchy problem. In Chapter II we give the classification of second-order PDEs in two variables based on the method of characteristics. A classification of almost-linear second-order PDEs in $n-$variables is also given. Chapter III is concerned with the one dimensional wave equation on the whole line, half-line and the mixed problem using the reflection method. The inhomogeneous equation as well as weak derivatives and weak solutions of the wave equation are also discussed. In Chapter IV the one dimensional diffusion equation is presented. The Maximum-minimum principle, the Poisson formula with applications and the reflection method are given. Chapter V contains an introduction to the theory of shock waves and conservation laws. Burgers' equation and Hopf–Cole transformation are discussed. In Chapter VI the Laplace equation on the plane and space is considered. In Chapter VII some basic theorems on Fourier series and orthogonal systems are given. Fourier methods for the wave, diffusion and Laplace equations are also considered. Finally, in Chapter VIII two and three dimensional wave and diffusion equations are considered.

Model examples are given illustrated by software products as *Mathematica* and MAPLE in ScientifiCWorkPlacE. Programs in *Mathematica* for those examples are presented."

Contents:

- First-Order Partial Differential Equations
- Second-Order Partial Differential Equations
- One-Dimensional Wave Equation
- One-Dimensional Diffusion Equation
- Shock Waves and Conservation Laws
- The Laplace Equation
- Fourier Series and Fourier Method for PDEs
- Diffusion and Wave Equations in Higher Dimensions

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