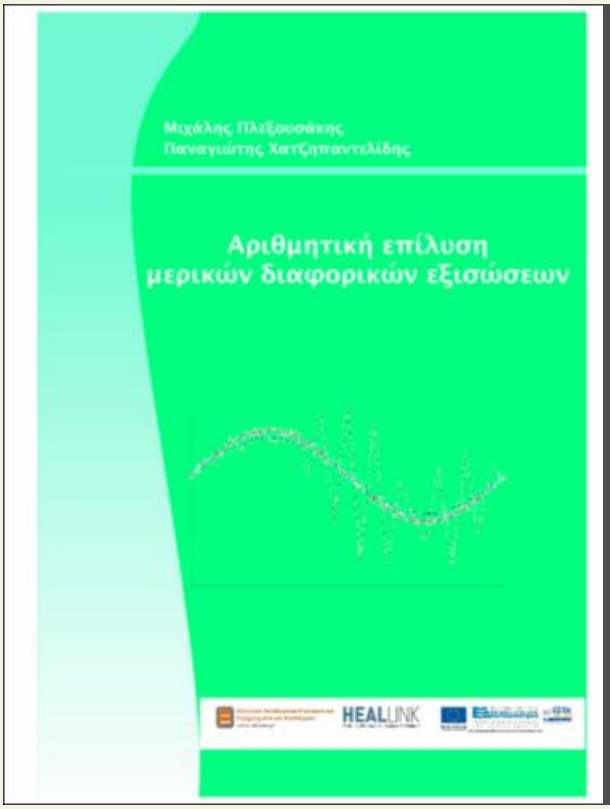

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Abstract

This book is addressed to undergraduate and graduate students of science and engineering schools. A main subject of teaching in these schools is the understanding of various physical phenomena through their mathematical modelling. The latter is done by formulating them as boundary or initial-boundary value problems for differential equations with partial derivatives. In most cases, we cannot find an exact solution explicitly, therefore we rely on the implementation of numerical methods on computers to construct approximations. Here, we consider boundary value problems for elliptic differential equations in one or two spatial variables and initial and boundary value problems for the heat equation, the wave equation and the transport equation in one or two spatial variables. For the numerical solution of the above problems, we consider finite difference methods and finite element methods. For the discretization in space, we employ either finite difference methods or finite element methods, and for the discretization in time we use various finite difference methods. We show various theoretical results concerning the stability, consistency and convergence of the above numerical methods. In addition, we present numerical examples supplemented by graphs and tables of results. At the end of each chapter there is a series of exercises for the prospective student to better understand the corresponding chapter.

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