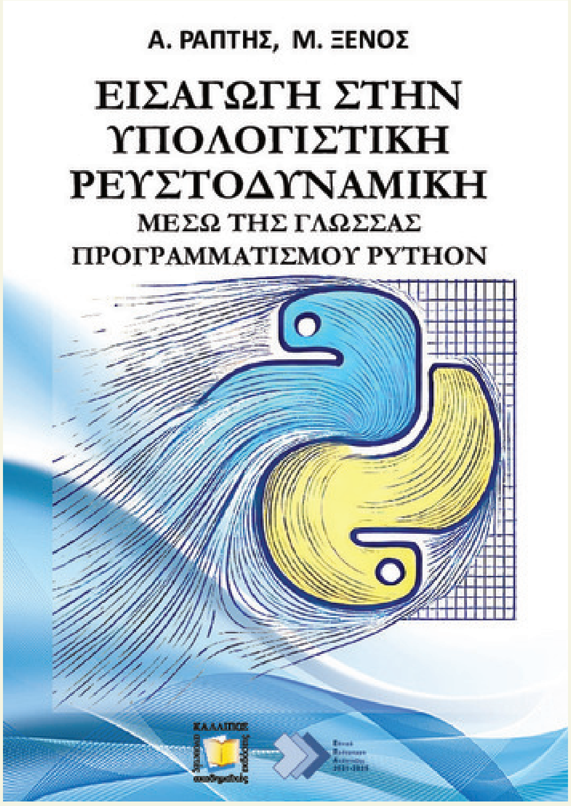

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Abstract

The problems of Fluid Mechanics are described by nonlinear, coupled systems of partial differential equations (PDEs), making their analytical solution extremely challenging. For this reason, numerical methods are required. This book presents the numerical methods applied to Fluid Mechanics problems, capable of providing accurate numerical solutions. Initially, reference is made to the Python programming language, which is used for the numerical solution of PDE systems. The classification of PDE systems is then introduced through characteristics and the determinant of the coefficients of the unknowns. The concept of a well-posed problem is explained, along with the initial and boundary conditions necessary for solving PDE problems. The most fundamental numerical methods used in Fluid Mechanics include the finite difference method, the finite volume method, and the spectral method. The application of numerical methods begins with solving the diffusion equation, followed by the Laplace and Poisson equations. Next, the solution of the advection equation and problems of steady advection-diffusion is addressed. The Burger's and Korteweg-de Vries equations are numerically solved using appropriate methods. Finally, the numerical solution of the primary flow equations of Navier-Stokes is presented. The book concludes with key applications, such as flow in a rectangular cavity, channel flow etc. Each chapter includes solved exercises to enhance understanding of the theory and the implementation of computational code for solving Fluid Mechanics problems. Additionally, unsolved exercises are provided for further practice.

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