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Abstract

This book provides an introduction to Computational Fluid Dynamics (CFD). The way a Computational Fluid Dynamics code works is briefly presented, the advantages and disadvantages of using Computational Fluid Dynamics in both research and industry are described, and several applications of CFD are also mentioned. In addition, the necessary mathematical theory for the dynamics and kinetic description of a fluid using the basic principles of conservation (mass, momentum and energy) is presented. Elements of numerical methods are analysed, important properties of a CFD code are discussed, and errors and uncertainties encountered in numerical methods are discussed extensively. The finite difference and finite volume methods are presented in detail, where the basic mathematical principles of these methods and the ways of approaching different types of derivatives encountered in different

equations are mentioned. In this context, typical examples of problems that are solved using the above methods and code examples in Python language are provided. A part of this book is also devoted to studying the solution of the Navier-Stokes equations by numerical methods. The selection of the appropriate mesh is analyzed, and the main numerical algorithms that refer to the solution of the Navier-Stokes equations are presented, while reference is also made to other known methods of solving the Navier-Stokes equations. Furthermore, this book presents the main and most well-known methods of solving discretized equations, where reference is made to the ways of managing and solving non-linear equations. Finally, the last chapters of the book present complex geometric flow problems in algorithms, turbulent flow problems with CFD algorithms, as well as special topics.

