Introduction to Theoretical and Computational Fluid Dynamics

Constantine Pozrikidis

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This book discusses the fundamental principles and equations governing the motion of incompressible Newtonian fluids, and simultaneously introduces analytical and numerical methods for solving a broad range of pertinent problems. Topics include an in-depth discussion of kinematics, elements of differential geometry of lines and surfaces, vortex dynamics, properties and computation of interfacial shapes in hydrostatics, exact solutions, flow at low Reynolds numbers, interfacial flows, hydrodynamic stability, boundary-layer analysis, vortex motion, boundary-integral methods for potential and Stokes flow, principles of computational fluid dynamics (CFD), and finite-difference methods for Navier-Stokes flow.

The discourse includes classical and original topics, as well as derivations accompanied by solved and unsolved problems that illustrate the theoretical results and explain the implementation of the numerical methods. Appendices provide a wealth of information and establish the necessary mathematical and numerical framework.

A unique and comprehensive synthesis of the essential aspects of the discipline, this volume serves as an ideal textbook in several graduate courses on theoretical and computational fluid dynamics, applied mathematics, and scientific computing. The material is an indispensable resource for professionals and researchers in various fields of science, chemical, mechanical, biomechanical, civil and aerospace engineering.

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