

Preface to the Second Edition

The scientific tripod is based on the three subjects (in alphabetical order to avoid a value judgment): computation, experiment, and theory. It is obvious at the very beginning of this millennium that the analytical and theoretical approaches have lost their impact and influence on research developments. The exponential growth of computer power has made simulations and visualization tools the effective and relevant devices to elaborate new models, new designs, and new technologies.

However, the domain covered by the fluid mechanics discipline is quite large and turbulence in flows is still a challenging problem in classical physics. Therefore the need for theoretical analyses of simple situations is still required in order to build up a line of reasoning helping the scientist to understand the basic phenomena. In the realm of reductionism that decomposes complicated matters into simpler problems, the simple solutions form the background of more complex cases with our intellectual abilities and educational biases to practice linear superposition. As soon as we tackle nonlinear physics we have to rely on the toolbox provided with those instruments in such a way that we can “think out of the box.” Even though the Chinese Wise Man wrote “A picture is better than a thousand words” an image does not yield any explanation nor insight views. Leonardo wrote “Mechanics is the paradise of the mathematical sciences, because by means of it one comes to the fruits of mathematics”; replace “Mechanics” by “Fluid mechanics” and here we are.

The author of the first edition, although still teaching, has been away from research for 20 years. Therefore, to bring the book up to date, a second author who is more current has been added.

Half a century later, the preface to the first edition seems prophetic. Aspects of hydrodynamics once considered offbeat have indeed become important. The authors, for example, have worked on problems where variations in viscosity and surface tension cannot be ignored. Also, the advent of nanotechnology has expanded interest in the hydrodynamics of thin films, and hydromagnetic effects and radiative heat transfer are now routinely encountered in materials processing.

This monograph addresses the basic principles of fluid mechanics and solves fluid flow problems where viscous effects are the dominant physical phenomena.

Readers who are interested in aerodynamics and turbulence applications are invited to refer to the large body of literature that cover those fields.

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Changes in the New Edition

Many misprints and some outright errors in the first edition have been corrected here. Topics new to the second edition include the second principle of thermodynamics, Boussinesq approximation, time dependent flows, Marangoni convection, Kovasznay flow, plane periodic solutions, Hele-Shaw cells, Stokeslets, rotlets, finite element methods, Wannier flow, corner eddies, and analysis of the Stokes operator. In keeping with the spirit of the first edition, we seek to supplement the existing literature, not to compete with it. Since 1964, for example, there has been an enormous literature about slow flow past obstacles. We discuss it but make no attempt to replicate it.

The bibliography is no longer presented at the end of each chapter. References are collected at the end of the monograph.

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