PREFACE

This book contains examples and problems in hydrodynamics that were an integral part of a theoretical course delivered at the Ural State University over many years. There are more than 200 examples and problems supplemented by answers and solutions.

In this textbook we primarily propose the problems, the physical content of which is rather transparent, and the process of solving allows the reader to see all the beauty of hydrodynamics. We have deliberately excluded problems whose solution might require rigorous mathematical proofs of different theorems and statements.

The first chapter is devoted to the foundations of tensor calculus. Although at first the reader may wish to skip over this chapter, we included it because in studies of hydrodynamics one uses existing equations written, as a rule, in Cartesian, spherical, and cylindrical coordinates. And here, two difficulties emerge: first, the need for an understanding of how these equations are derived, and second, facility with writing them for other symmetries (parabolic, elliptical, etc.), since a wide variety of symmetries are encountered in studies of natural phenomena, and it is the most convent to use the appropriate curvilinear coordinates. With the answers to problems from the first chapter, readers can write the Navier–Stokes equations and the continuity equation in all coordinates considered in the text; moreover, if they understand how these equations are derived, it will be not a particular problem to write the equations in question in any other curvilinear coordinates.

The second and third chapters are devoted to dimensional analysis and self-similar solutions. We deliberately placed these chapters before consideration of the basic issues of hydrodynamics: inviscid and viscous fluids. The reasons are the following. First, the methods outlined in the second and third chapters often allow one to solve intricate problems easily. Second, dimensional analysis and self-similar solutions are of interest in themselves, and appear helpful in different branches of modern phys-

ics. Several examples are proposed. At this point we thank professors V. V. Mansurov and V. S. Nustrov for help in writing the first three chapters.

The fourth and fifth chapters, which discuss inviscid and viscous fluids, numerous examples that demonstrate workable approaches to analytically solvable problems.

During our work on this book we used many original sources. Some of them are rare or may be inaccessible to the reader, others are accessible only to Russian readers.

We hope that this book will help students to understand and master the main issues of hydrodynamics. Also we hope that it will be useful for lecturers and instructors.

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