

# Preface

The book is devoted to the Buckingham Pi-theorem and its applications to various phenomena in nature and engineering. The accent is made on problems characteristic of heat and mass transfer in solid bodies, as well as in laminar and turbulent flows of liquids and gases. Such choice is not accidental. It is dictated by the requirements of modern technology and encompasses a vast majority of important problems related with drag and heat transfer experienced by solid bodies moving in viscous fluids. These problems involve the evaluation of temperature fields in media with constant and temperature-dependent thermal diffusivity, heat and mass transfer in boundary layers, pipe and jet flows, as well as thermal processes occurring in reactive media. In all these cases a uniform approach to the corresponding complex thermohydrodynamical problems is used. It is based on the direct application of the Pi-theorem to the analysis of two types of problems: those which admit a rigorous mathematical formulation, as well as those for which such formulation is unavailable. For the former problems our attention will be focused on the establishment of self-similarity which reduces the governing partial differential equations to the ordinary ones by means of the Pi-theorem, whereas for the latter problems the Pi-theorem will be used to reveal a set of the governing dimensionless groups. To a certain degree the choice of the problems is subjective. However, it allows the evaluation of the range of possible applications of the Pi-theorem and the peculiarities characteristic of the complex thermohydrodynamical processes in continuous media.

The book consists of nine chapters. They deal with the basics of the dimensional analysis, the application of the Pi-theorem to find self-similarities and reduce partial differential equations to the ordinary ones. Then, such interrelated topics as the drag force, laminar flows in channels, pipes and jets are covered in detail. The discussion also involves kindred heat and mass transfer in natural, forced and mixed convection and in situations with phase change and chemical reactions. Some problems of turbulence theory are also covered in the framework of the Pi-theorem. In addition to the in-depth exposition of the basic theory and the generic problems, a number of worked examples of problems related to the application of the Pi-theorem to different hydrodynamic, heat and mass transfer questions are presented in the end of each chapter. They can be of interest to the engineering and physics students.

The book is intended to scientists and engineers interested in hydrodynamic and heat and mass transfer problems. It could also be useful to graduate students studying mechanical, civil and chemical engineering, as well as applied physics.

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The Pi-Theorem

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