

# Preface

The purpose of this book is to help students understand the principles, methods and applications of continuum mechanics. With this aim the authors consider more than one thousand problems in continuum mechanics.

The subject of continuum mechanics deals with the behavior of any deformable media under different physical conditions. Different mathematical models are applicable for the same medium, depending on the purpose of the study and the physical environment. These models correspond to different fields of continuum mechanics such as fluid and gas mechanics, hydraulics, theory of elasticity and plasticity, creep theory, strength of materials and others. Students specializing in one of these areas often pay attention only to that one area. However, a deeper understanding can be achieved if students are exposed to how general principles work under different conditions and to the various results that are given by different models for the same conditions. These aspects the authors tried to demonstrate by collecting problems associated with the general principles of continuum mechanics, as well as certain particular problems and models. Thus, the characteristic feature of this book is that the problems collected in it aim at exhibiting both the variety and the unity of the ideas and methods of continuum mechanics.

Let us mention one example of this approach. There are many phenomena in which we observe abrupt changes of the velocity, pressure and other parameters. In continuum mechanics these abrupt changes are usually considered as discontinuities of the parameters. To describe them one needs to use the conservation laws, the second law of thermodynamics, the evolutionarity conditions, as well as conditions for stability and the existence of a structure. In the book the use of all these conditions is demonstrated not only for shock, detonation and combustion fronts in gas flows but also for interfaces between water and rain falling on it, for shocks in elastic solids, for discontinuity of electromagnetic field, for hydraulic jumps in channels, and even for road traffic.

The problems included in the book are at various levels of difficulty. Some of them are more or less standard exercises that are necessary for understanding the subject. Others are much more realistic, requiring extensive creative work and giving some understanding of state-of-the-art problems. Indeed non-traditional problems

in nonlinear elasticity, microinhomogeneous averaging, interaction of continua with electromagnetic field, viscoelasticity and plasticity theory, applications of tensor analysis (in particular, nonlinear tensor function theory), and creation of new continuum models are all included.

All the problems in the book are provided with answers, most of them with hints and solutions. Each group of problems is preceded by a corresponding theoretical review. These sections help not only in solving the problems but also in understanding the general structure of continuum mechanics. However, study from this book should be supplemented by the reading of other texts.

The authors hope that the book will be useful for undergraduate and graduate students, and also for engineers and researchers in mechanics, mathematics and physics.

A few words about the contributors to this book. The book was written by the professors of the Department of Hydrodynamics at the M. V. Lomonosov Moscow State University. The Department Chairman L. I. Sedov did a lot to unify the continuum mechanics from the set of separate subjects. For many years the authors taught the basic course of continuum mechanics and its various branches: hydrodynamics, gas dynamics, elasticity theory, plasticity theory, thermodynamics and electrodynamics of continua, application of dimensional analysis and modeling of the continuous media. All the authors are also do active research in continuum mechanics. M. E. Eglit and D. H. Hodges were editors. A. N. Tiatiushkin translated the book from Russian into English; he also remarked and corrected some inexactitudes in the formulations of problems. The computer graphics was made by E. N. Paschenko. V. A. Turkov and V. A. Naliotova performed a computer typesetting of the book; this great work required the thorough understanding of contents of the book. A. G. Kalugin, N. I. Gvozdovskaia and V. V. Volovoi helped very much to put the manuscript into proper shape. It is hard to estimate the help of V. G. Sutyurin and A. E. Yakubenko, without whom the appearance of this book would be impossible. They took part in the making of the book from the very beginning, typing preliminary versions and giving very useful advice concerning the contents and form of the book. V. G. Sutyurin provided the connection between Russian and American editors. V. G. Sutyurin and E. V. Soutyrina worked very hard making the final version of the book ready to publication. At the first stage of work on the book authors had very useful discussions with V. V. Rosantzeva on its contents. At last, V. L. Berdichevsky should be noted who had the idea of publishing the book in English, had read the first chapters of the book and made a number of important comments.

The authors are grateful to all these persons.

Margarita E. Eglit,  
Moscow, August 1, 1995