

Foreword

In the twenty first century much of Applied Science is concerned with problems of great subtlety and complexity, and the greater the difficulty the more sophisticated are the mathematical and computational techniques needed in order to make significant progress. It is therefore particularly unfortunate that the gap between applied scientists and mathematicians is growing, indeed one is tempted to say has grown, so large that these groups are usually unable to understand each other and so to communicate. The training of undergraduate applied scientists frequently fails to cover even the basic level of the powerful mathematical tools available. On the other hand, mathematical students often learn little about the problems which originally motivated the very mathematics they are studying. Thus communication between the various groups at research level is often exceedingly difficult, and as a consequence joint research, essential now in many areas, faces major obstacles. It is thus timely that the present volume, which is aimed at bridging the gap, should appear.

The book is aimed, on the one hand, at those who study that part of Applied Science dealing with the properties and dynamics of materials, that is Continuum Mechanics. “Materials” in this context may cover a wide range of substances, from fluids to steel to exotic plastics for example with memory; such a range is of obvious importance to almost all types of engineering disciplines, including aeronautics, metallurgy, and civil engineering to mention just a few. Less obvious perhaps, but just as important, is the central role of Continuum Mechanics in several other branches of Applied Science, for example Earth Science, where the properties and movements of the core and mantel of the earth are much studied in traditional contexts such as Volcanology, but also have recently become headline issues with their connection with the safety of storage of nuclear waste.

On the other hand, the book will be of interest to the many mathematicians who are unaware of the wide range of problems to which mathematics may be applied in an interesting and effective manner. They may also be unfamiliar with the extension of standard results which are needed in applications. Thus for example, although functional analysts will know a great deal about Banach spaces and linear operators on them, they may not be familiar with how solving practical problems necessitated the introduction of Sobolev Spaces and of generalised solutions for a whole class of differential equations.

A brief outline of the approach of the authors is as follows. The aim is to start with classical Newtonian Mechanics and then to proceed to show carefully how the basic structure of the governing equations of continuum mechanics are developed. Of course it would be impossible in a single volume to cover the ramifications of this vast subject, however, the methods the authors put in place form the basis for extension to rather general settings. In the development, some key tools of mathematics are introduced naturally and it is shown how they are instrumental in gaining insight into the applications. The first is the Calculus of Variations. The great power of this theory is perhaps unfamiliar to most people without a considerable mathematical background, and the authors outline how effective its methods are in deriving the basic equations as well as in devising powerful solution techniques including numerical methods.

The second main mathematical area introduced is Functional Analysis, the basic theory of which is developed here. Several of its wide-ranging implications are covered in the book. In particular, the authors describe with great elegance how the idea of a generalised solution, which may at first sound obscure, actually much simplifies the analysis of the differential equations associated with continuum mechanics, and in particular is important in understanding the meaning and accuracy of numerical methods, particularly when they are applied to common engineering problems with, for example, discontinuous loads.

The book is written jointly by an engineer and a mathematician, and is sensitive to the background of both applied scientists and mathematicians. The authors take great care to introduce the material in such a way that it is readily available and interesting to each group. I believe that many students and researchers in both categories would benefit a great deal from a study of this excellent volume.

University of Sheffield
England

V. Hutson