

Preface

Just to make it clear from the very start: This is not a monograph for the specialists who are looking for a compendium on continuum theory. Rather I attempt to fill a niche with this book, which started to widen after our government in all their infinite wisdom decided to terminate the diploma syllabi at German Universities and replace them by bachelor and master modules instead:

True students of engineering have a notorious aversion to mathematical abstraction. They prefer a quick and dirty way of solution, in particular when modeling the behavior of advanced materials in complex technical systems. The usual, highly formalized textbooks on continuum theory do not really support such an approach. Even their last resorts, for example consulting the user manuals of the all-time-favorite finite element codes, are blocked, because the same cryptic symbols are lurking there. On the other hand, students of physics face another problem, which is due to the way physics is commonly taught. They hear much about discrete systems, in particular in mechanics and in thermodynamics. The concept of fields is usually not presented before they attend classes on electrodynamics or quantum mechanics. Finally, the education of both groups of students has in common that usually no difference is made between the laws of nature (the balances of mass, momentum, energy, etc.) and constitutive equations. Both are usually well mixed to form a hodge-podge of recipes. The best examples are the NAVIER–STOKES equations. Moreover, every subject of physics, i.e., mechanics, thermodynamics, electrodynamics, etc., is usually taught separately without emphasizing the connections and the similarities. This is definitely not what we need when developing modern technologies, which only thrive because of their multiphysics interaction.

This is where continuum theory can help. It provides a bridge between the various subjects, by working out a common structure and by emphasizing the common roots. In this context constitutive equations form a most essential joint.

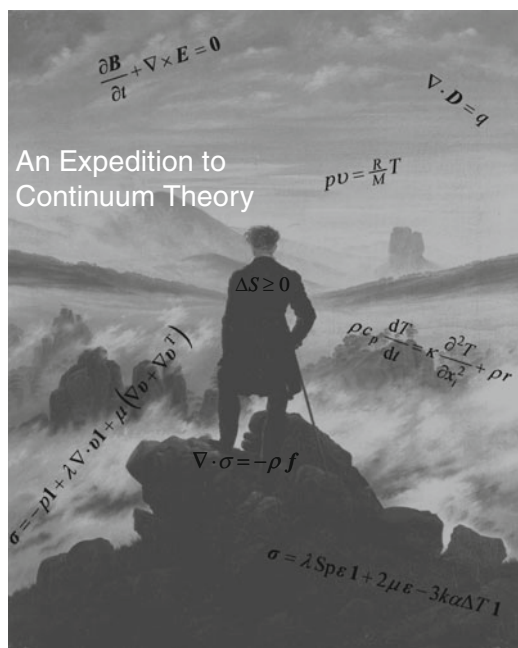
This is where this book sets in. It is the result of two teaching modules of four contact hours per week each. These modules are currently taught at TU Berlin, in particular in the master course Physical Engineering Science. The exercises compiled in this book play an important role in the teaching: Approximately two of the four hours per week are reserved for a seminar, where each student presents one of the various problems. Moreover, further problems are worked out in written form every week. Thus the students study the subject matter on a continuous basis, throughout the semester. They are forced to learn for their future job and not just

for a final examination, after which they may forget everything immediately. Another side effect of this hard way of learning is to make sure that the students do not study singular aspects of continuum theory and ignore the rest. And, finally, the students learn from each other so that collectivism can be good for something after all.

Another important aspect of this book is to educate students in tensor calculus both in abstract as well as in index notation. Future engineers and physicists must be able to perform calculations in their daily practice, which is why the latter method is particularly important.

Finally, I would like to thank all those who helped me with this book. First of all, Prof. Ingo Müller and Priv.-Doz. Dr. Wolf Weiss, who contributed to various sections that were not included in the German edition of this book. Further credits are due to Messrs. B. Emek Abali, M.Sc., Dipl.-Ing. Benjamin Schmorl, and Felix Reich, M.Sc. The latter contributed in particular Exercises 13.2.3, 13.4.1, and 13.4.2. Several students found typos in the book: Messrs. Heinrich Grümmer, Wilhelm Hübner, Andre Klunker, Christian Seidel, and Oliver Stahn. Finally, I would like to thank Springer Engineering in the Netherlands, in particular Ms. Nathalie Jacobs and Ms. Cynthia Feenstra.

And now we start



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