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Mathematics for Physicists. Introductory Concepts and Methods. By Alexander Altland and Jan von Delft. Cambridge University Press, 2019. Hardback, Pp. 720. Price GBP 39.99. ISBN 9781108471220.

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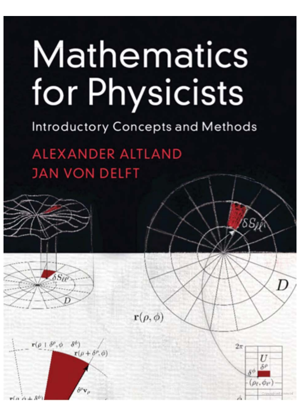

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There are many books available these days on mathematics and its applications in subjects such as physics. This is one of the latest in a long line, and so one has to ask, what is new? This is a large book covering 700 pages, including the index, weighing in at 1.7 kg (!), so one can expect an extensive treatment of the subject.

The authors are both Professors of Theoretical Physics (Altland at the University of Cologne, von Delft at the University of Münich) and so are highly qualified to address the way in which mathematics should be taught to physicists, as opposed to by mathematicians. I remember myself, as an undergraduate in chemistry, having to attend endless lectures taught by mathematicians, and coming away confused. The authors' claim is that this is a textbook that guides the reader from high-school level (I am not sure if this would be true for the high-school levels with which I am familiar) to advanced subjects such as tensor algebra, complex functions and differential geometry. It contains all the material required in the undergraduate curriculum and emphasises a pedagogical strategy that presents a unified approach of concepts and methods, whereas most mathematics books for physicists tend to concentrate on methods. That is a welcome addition to the literature, but it is what makes this book so large.

The book is divided into many different sections, starting with topics on linear algebra, before going on to calculus and vector calculus, and ending with comprehensive solutions. At the end of each topic, a useful set of problems is given to firm up one's understanding.

In the linear algebra section, which covers approximately 200 pages, the authors begin with defining a lot of terminology in the areas of sets and maps, groups and numbers (rational and real). They then proceed to discuss vector spaces, affine and Euclidean spaces, isomorphisms *etc.* This is followed by sections on vector products, linear maps, determinants, matrices, and linear algebra in function spaces.

The topic of calculus covers the usual areas of differentiation and integration of functions, plus other important areas such as Fourier calculus, taking us to approximately 400 pages. The vector calculus topic addresses the mathematics of curves and fields, a very useful section for physicists wanting to understand subjects such as electrodynamics, and this section takes us up to about 560 pages.

Throughout the whole book, there are more than 300 set problems. Thus, the book ends with 130 pages giving the solutions to all the odd-numbered problems set earlier (the remainder of the book being the index). The authors state here that a password-protected manual containing the solutions to the even-numbered problems will be made available to instructors!

So, what do I think about this book? Well, it is clearly an in-depth tour de force by the authors, and frankly to read it and take in everything needs considerable concentration. It is well written with excellent diagrams and historical notes. The authors have clearly done a fine job. It does take some time to master some of the jargon, especially in the early sections, but I think that if one is prepared to persevere, much useful material can be learnt. It is an excellent treatment of the sort of mathematics needed in a subject such as theoretical physics, but it is a pity that a critical area of physics has been left out, namely a proper treatment of the mathematics of symmetry. Symmetry, after all, lies at the heart of crystallography (although, I guess, some may argue that crystallography does not belong in physics), but especially in condensed matter physics theory (where it is all important). There is a small amount relating to groups but not, in my view, enough relating to the science of the solid state. But then the book would be even larger: perhaps a two-volume edition would be welcome.

Would I recommend this book? Well, yes, if high-level theoretical physics is your thing, but be prepared for a lot of hard study. If, on the other hand, you want a mathematics textbook with a lighter touch and an easier guide to how to use mathematics, this book is probably not for you.