this instance, since it lists eight references to the multiplication operator, but not the one where the term is first encountered.

Life is also made harder than necessary by the absence of Q.E.D. signs, or some equivalent indication of where proofs end. Chapters are referred to as sections, making it difficult to distinguish between chapters and sections within a chapter, numbered equations and results are sometimes referred to by the wrong number, unnumbered equations by number, and various typographical styles of numbering are used.

Throughout the book one is struck by the contrast between the content, treatment, and organisation of material, which are excellent, and these shortcomings in presentation. One sometimes has the impression that, what we have here is an excellent set of notes, which were rather hastily brought out in book form. In spite of its drawbacks, this is a very good introduction to the spectral theory of linear operators and a new, more careful, edition is bound to be popular.

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Book Review

AN INTRODUCTION TO ALGEBRAIC TOPOLOGY

(Graduate Texts in Mathematics 119)

Joseph J. Rotman

Springer-Verlag, 1988, 433pp.
ISBN 0-387-96678-1

Reviewed by Graham Ellis

This is a well written, often chatty, introduction to algebraic topology which "goes beyond the definition of the Klein bottle, and yet is not a personal communication to J. H. C. Whitehead." Having read this book, a student would be well able to use J.F.Adams' *Algebraic Topology: A Student's Guide* to find direction for further study. The book begins with a sketch proof of the Brouwer fixed point theorem: if $f\colon D^n \to D^n$ is continuous, then there is an $x \in D^n$ such that $f(x) = x$. *Functorial* properties of *homology groups* imply that the sphere S^n is not a retract of the disc D^n, and then a simple argument by contradiction shows that f must have a fixed point. This illustrates the basic idea of studying topological spaces by assigning algebraic entities to them in a functorial way. There follows a rigorous account of the singular homology of a space which assumes only a modest knowledge of point-set topology and a familiarity with groups and rings. The account includes the Hurewicz map from the fundamental group to the first homology group, and ends with a proof of the Mayer-Vietoris sequence. By p. 110 a complete proof of Brouwer's theorem has been given. Singular homology is good for obtaining theoretical results, but not so good for computations. So simplicial homology is introduced in Chapter 7, and used to compute the homology groups of some simple spaces such as the torus and the real projective plane. A proof of the Seifert-Van Kampen theorem for polyhedra is given at the end of the chapter. Continuing the search for effective means of computing homology groups, Chapter 8 introduces CW complexes and their cellular homology. Chapter 9 begins with a statement (without proof) of the axiomatic characterization of homology theories due to Eilenberg and Steenrod, and then introduces enough homological algebra to prove the Eilenberg-Zilber theorem and Künneth formula for the homology of a product of spaces. Chapter 10 deals with covering spaces. The higher homotopy groups are studied in Chapter 11 using the suspension and loop functors. Results obtained include the exact homotopy sequence of a fibration, and its application to the fibration $S^3 \to S^2$ to show that the group $\pi_3(S^2)$ is non-trivial. The isomorphism $\pi_3(S^2) = \mathbf{Z}$ is beyond the scope of the book. In the final chapter a short discussion on de Rahm cohomology is used to motivate the study of the cohomology ring of a space.

The book is nicely structured, with explanations of where the theory is heading given at frequent intervals. Important definitions are often accompanied by a discussion on their origins. Many exercises are given at the end of sections. Proofs are usually given in full detail. Even though probably every result in the book (and many more besides) can be found in E.H. Spanier's classic text *Algebraic Topology*, J.J. Rotman's style of exposition makes the book a useful reference. However a lecture course based on this book may turn out to be a bit slow and dry. (Unfortunately the book corresponds to the syllabus of a one year course given at the University of Illinois, Urbana.) For example the homology of a space is defined on p. 66 but we have to wait until p. 157 until the homology of the torus is calculated, and until p. 226 for the homology of a lens space. The fundamental group is introduced on p. 44 but isn't calculated for a wedge of two circles until p. 171. Maybe too much rigour and generality in a first course on any topic is not a good thing!

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Book Review

INTRODUCTORY MATHEMATICS THROUGH SCIENCE APPLICATIONS

J. Berry, A. Norcliffe & S. Humble

Cambridge University Press, 1989,
stg£45 (hardback) ISBN 0 521 24119 7,
stg£15 (paperback) ISBN 0 521 28446 5.

Reviewed by Martin Stynes

For most of this century, pure (as opposed to applied) mathematics has held the centre of the mathematics stage. The last twenty years have seen a significant change in emphasis; today, applied mathematics is at least an equal partner. This trend has been reflected at the teaching level by the introduction of "new" topics such as discrete mathematics and dynamical systems, but it has not yet had much effect on the teaching of traditional courses such as calculus and linear algebra (except that sometimes these traditional courses disappear to make room for new courses). Textbooks for traditional courses now tend to use more applied material than heretofore, but the ratio of " applied" to " non-applied" examples is still low in the vast majority of cases. In this respect the book by Berry, Norcliffe & Humble is to be welcomed. Most of its examples are applied; they come from biology, chemistry and especially physics. As the authors state: " There is a growing awareness that we must not teach mathematics in isolation from its applications".

The book is intended for first-year service courses in science or engineering. It devotes approximately 150p. to pre-calculus material, 80p. to differentiation, 70p. to integration, 60p. to ordinary differential equations, 60p. to partial differentiation, and 100p. to