may exist. It matters very little whether one agrees with any (or all) of Romer's conclusions; the value of the book is that it will make it easier for the newcomer to inform himself and thus to make up his own mind. In this, I think it succeeds admirably. It is, like Romer's other books, extremely well written, and one suspects that he enjoyed writing it almost as much as one enjoys reading it. One's only criticism is that its price seems rather high; however I understand that a cheaper paperback edition will be available in the autumn. BARRY COX

MATHS FOR THE SCIENTIST

Outline Course of Pure Mathematics

By A. F. Horadam. Pp. xvi + 578. (Pergamon Press: London, Oxford and New York, February 1969.) 70*s*; $9.

THE convenience of having a course for the science undergraduate in his first year, to embrace in a single volume all the relevant pure mathematics, is evident. The author has drawn on his experience at the University of New England, Armidale, Australia, and differences in educational systems must be remembered; practically all the material in this volume would be dealt with here in a good science sixth form.

Some knowledge of elementary calculus is assumed, and on this basis the work looks chiefly to applications; partial differentiation is included, multiple integrals excluded, and rather surprisingly there is nothing in the main text about differential equations, though simple instances crop up in the examples. Fundamental theorems in analysis, such as the Mean Value Theorem, are precisely stated, but are often not analytically proved, geometrical illustration and intuition being used as supports. This is probably appropriate for students who are naturally more interested in the applications of the calculus rather than the techniques of the professional mathematician, and is usually adequate, though the proof that a continuous function is integrable seems defective, applying only to a piece-wise monotonic function. Some chapters at the end of the book give the usual geometrical applications of the calculus to curves, areas and so on.

An acquaintance with modern ideas in algebra is now essential for the young scientist, and chapters on matrices, determinants, vectors, sets, Boolean algebra and groups will give him the broad outline required, with plenty of exercises for the filling-in of details and for the simpler applications.

The chapters on geometry are somewhat disappointing. They begin well enough with interesting accounts of homogeneous coordinates, elements at infinity, the euclidean group and Klein's group-characterization of geometry. Then, however, attention is centred on the conics, defined doubly as plane sections of a cone and as curves having the focus-directrix property; for the proof that these lead effectively to the same class of curves the reader is referred elsewhere. These definitions lead to equations of the second degree, and general properties are obtained. But at this stage a slightly more sophisticated approach might be more stimulating. Having examined the nature of loci defined by equations of the first degree, a natural problem is to go on to the examination of loci defined by equations of the second degree, and this would give the author even more scope for employing the vector and matrix methods already developed. There is no three-dimensional geometry.

About 1,100 exercises provide not only routine drill but also many problems taken from the field of the natural sciences, some easy, some requiring a little serious thought. A remarkable feature of the book, which will particularly endear it to the student who has to work on his own, is that solutions are furnished for all the exercises.

T. A. A. BROADBENT

MATHEMATICAL INTENSITY

Mathematical Foundations of Network Analysis

By Paul Slepian. (Springer Tracts in Natural Philosophy, Vol. 16.) Pp. xi + 195. (Springer-Verlag: Berlin and New York, 1968.) 44 DM; $11.

THE analysis of linear resistance networks using Kirchhoff's laws is a simple problem in linear algebra. It is greatly illuminated by graph theory and the use of incidence matrices. The concept of "independent loop currents", introduced by Maxwell and successfully used by countless engineers, now enjoys a precision it formerly lacked, and the whole theory, elegant and rigorous, can be found, for example, in Seshu and Reed's *Linear Graphs and Electrical Networks*. In particular, Kirchhoff's "topological" formulae are easily proved by using the Binet–Cauchy theorem for determinants.

There is, however, a school of mathematical thought today which believes one should not move a step without invoking the full apparatus of abstract set theory, functions on sets, linear maps, range, domain and so on. Professor Slepian evidently belongs to this school, and he has converted network analysis into a branch of algebraic topology. The result is a book of which a large part is quite frightening in its mathematical intensity, and which in my opinion presents a travesty of the subject.

In a careful reading of the book, I have found no mathematical errors—but I must report that in many places, even on his own ground, the author's proofs are absurdly long, often because of the excessive use of the "canonical base" Φ introduced on page 63. If, instead, one uses a function $F(x,y;z)$ of a directed branch (x,y) and vertex z, equal to 1 if $z=y$, -1 if $z=x$, 0 otherwise, a much more powerful and concise treatment becomes possible. For example, the 2-page proof (including antecedents) of theorem 2, page 83, and the 3-page proof of theorem 3, page 92, would each be reduced to a few lines.

In view of these defects, the frequent displays of intellectual arrogance, implying that previous writers on the subject have been imprecise or inadequate, and typified by the extraordinary section in which a matrix is defined, are all the more unfortunate.

The author hopes, in the introduction, that the "more precise tools" made available by him will assist in network synthesis. I shall be very surprised if this ever happens. Meanwhile, this book does not justify itself by a single worthwhile new result in network analysis.

A. TALBOT

WAVE PHYSICS

The Physics of Vibrations and Waves

By H. J. Pain. Pp. xiii + 241. (Wiley: London and New York, December 1968.) 42*s*.

RECENTLY, several books have appeared in which the theory of vibrations and waves is applied to a variety of topics. This is a welcome change from the type of text which confines the discussion to one branch of physics, such as acoustics. H. J. Pain has adopted the broader approach and has produced a useful addition to books already available on the subject. The author states that the book has as its origin a course of first year undergraduate lectures but that additional material has been added. The subject matter is therefore more than could normally be covered in one year. The standard, however, is nowhere too high for a first year student: a knowledge of only school-leaving mathematics is required and additional mathematical techniques are introduced as the need arises.

Free and forced vibrations of systems of one degree of freedom are considered fully in the first two chapters. There follows a discussion of coupled oscillations in which