J. Fluid Mech. (1970), vol. 44, part 3, pp. 622–624
Printed in Great Britain

REVIEWS

Mathematics Applied to Physics. Edited by E. ROUBINE. Springer-Verlag, 1970. 610 pp. DM 58, $16.00.

Pure mathematics is like a great building ceaselessly being extended in a variety of styles and mostly conjured into existence by the thoughts of its architects without the gross intervention of bricks and mortar. Much of it is castles in the air, the free invention of clever minds. However, some parts of this vast edifice, including some of those most striking and beautiful, have a more substantial air about them, for they provide the framework of our understanding of the physical world. These rooms are not only there for the pleasure of viewing them; they are inhabited by the theoretical physicists and applied mathematicians. These earthy toilers sometimes have an uneasy suspicion that somewhere else in the vast palace are rooms so cunningly fashioned that what is now hard labour would in them become an easy pastime. However, the travelling is so slow and the palace so immense and the end of one's journey so uncertain that few make a sustained effort to find them. Indeed it often seems more satisfactory to try to knock up an extra room or two oneself with whatever materials come to hand, and some splendid chambers have in fact been created by the great in this way, occasionally duplicating what existed elsewhere.

The interplay of mathematics and physics poses educational problems. Theoretical physicists need to be mathematically articulate, to possess a wide vocabulary of concepts and techniques. However, they cannot tackle vast tracts of pure mathematics on the off chance they might one day be useful. Nor need they worry unduly about the *minutiae* of rigour or the higher flights of generality: it is enough to get the right answer in the particular case in question. Anything which presents them with powerful material in viable form is to be welcomed.

The book under review presents a series of articles on branches of mathematics which have proved their worth in theoretical physics. The style is concise and informative. Theorems are carefully stated and proofs are mercifully omitted. (It avoids the fallacy, popular among mathematicians, that one cannot use what one cannot prove, as if one needed to understand the reasons for the dynamical stability of a bicycle before one could ride it.) The choice of topics is classical, both in the sense of presenting mathematical material which is traditionally useful to physicists and also in treating methods mainly used in contexts where Planck's constant can be set equal to zero. There are chapters on functions of complex variables, theory of distributions, exterior differential forms, ordinary differential equations, partial differential equations, integral equations, numerical approximations to partial differential equations, probability theory, optimization, and quantum mechanics; the last being an elementary account of the representations of Lie groups. The authors form an international set. All articles but two are in English and the exceptions are in French. This reviewer concludes, from dipping into chapters about subjects he does not know about and reading chapters about subjects which are more familiar to him, that the level is advanced but hardly frontier and the exposition generally clear.

The book is a useful compendium of tried techniques. It could profitably be followed by a sequel which carried the tale a little further, blowing the mind with more powerful concoctions. Often it is the enlarged imagination which the mathematician can most usefully provide for the physicist. The detailed questions which the latter then asks he will usually have to answer for himself since mathematics does not tend to care for particularities. Examples of topics which could figure in such a sequal are much more material on functions of several complex variables and on Lie groups. It is an astonishing fact that these abstract theories seem to provide the right language for the physicist to use in discussing the behaviour of elementary particles.

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Introduction to Fluid Mechanics and Heat Transfer. By JERALD D. PARKER, JAMES H. BOGGS and EDWARD F. BLICK. Addison-Wesley, 1969. 612 pp. 140*s*.

Heat and Mass Transfer in Recirculating Flows. By A. D. GOSMAN, W. M. PUN, A. K. RUNCHAL, D. B. SPALDING and M. WOLFSHTEIN. Academic Press, 1969. 338 pp. 60*s*. or $9.50.

The two books under review are both intended as didactic works on heat transfer. Their level, range of subject matter, and intended audience, however, are quite different.

Introduction to Fluid Mechanics and Heat Transfer is intended as a text for undergraduate engineering students. A major consideration (as opposed to most available texts) is its presentation of fluid mechanics and heat transfer as a unified subject. In a time when undergraduate curricula are becoming crowded and yet the demand for reducing the student work load is heard on many sides, the combination of fluid mechanics and heat transfer into a single course and text appears quite reasonable. It would greatly reduce the repetition of fluid mechanics usually required in teaching a heat transfer course. However, though it is easy to argue that knowledge of fluid mechanics is essential to the study of heat transfer, the converse is perhaps less defensible.

The structure and order of presentation of material in the text is (as always) debatable. Thus, although conduction heat transfer can be taught independently of fluid mechanics, it is presented following material on convection, which, of course, requires some background in conduction. Similarly, the detailed material on heat exchangers preceeds the chapter on conduction, yet conduction is used as an important part of the analysis of a heat exchanger.

The book in general uses the partial differential equations for the velocity and thermal boundary layers rather than integral equations. This approach has the advantage of being more exact and offering more mathematical formalism, yet it suffers by not requiring a physical awareness of the participating phenomena. Even when the integral equations are derived in the text, it is by integration of the differential equations of the boundary layer rather than from a control volume, from which a better physical picture of the phenomena can be gained. In this respect the text may be more difficult for the undergraduate student than some of the books presently available, though it certainly should appeal to any who are interested in a more exact and formal approach, even for students starting their studies in fluid mechanics and heat transfer.

In general, this reviewer is sympathetic with the concept of combining fluid mechanics and heat transfer into a single course and feels the authors have contributed in providing a textbook that can be used in this manner.

Heat and Mass Transfer in Recirculating Flows was written to accompany an intensive course of lectures at Imperial College to an audience of engineers and research workers. It is intended for graduate students or workers in the field of fluid mechanics and heat transfer. The book is suitable either for a course of independent study or as part of a course specifically devoted to numerical methods of predicting heat and mass transfer. It presents a general computer program to solve steady, two-dimensional recirculating flow problems with heat and mass transfer.

Following some introductory material, the equations governing the physical processes are derived for an arbitrary co-ordinate system. Turbulence is handled either by the use of effective transport properties through a mixing length analysis or by the use of an effective viscosity determined from the kinetic energy of fluctuating motion (as first analysed by Kolmogorov and Prandtl). Considerable emphasis is put on the derivation of the equations and solution of the corresponding finite difference equations. The equations derived and used are second-order elliptical partial differential equations of the same form, so that they can all be treated identically in the computer program. Details of the basic program written in Fortran are presented and a wide variety of sample problems are solved.

The present book is perhaps the most general available work on finite difference solutions for recirculating turbulent flows. However, considerable physical input is still necessary. In general, the problems and examples given use the mixing length as an empirical hypothesis. Even the more fundamental and complicated Kolmogorov–Prandtl model requires considerable empirical information.

The book presents a means for predicting and comparing different heat transfer and flow phenomena within a fixed framework of numerical analysis and should prove very useful. Although primarily intended for turbulent flow problems, the basic equations are also valid for laminar flow.

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