Lucid applied math

MATHEMATICS FOR SCIENTISTS. By Thor A. Bak, Jonas Lichtenberg. 487 pp. W. A. Benjamin, New York, 1966. $15.00

by Peter L. Balise

With an ample choice of applied mathematics texts currently available, the appearance of another, especially a translation, is likely to be treated coolly. However, this revision of a 1960 Danish book, serving the authors' one-year course for chemists, biochemists and MD's doing basic research, is very attractive. Smoothly translated, it is marked by clear exposition and modern content. The problems (with answers) and index are sufficient.

The authors' empathy for the student is evident in the first chapter, on vectors and tensors, which carries the reader from elementary definitions to similarity transformations. Two- and three-dimensional illustrations dominate the presentation, but the extensions to n dimensions are made obvious. This reviewer shares the opinion of many teachers that geometric interpretations are most valuable in providing vividness with a modicum of rigor. Unfortunately, nonsymmetric matrices are ignored and there is only brief mention of repeated roots and complex matrices, important matters that would have been interesting to see treated by the authors with their accustomed clarity.

There are lucid expositions of other major topics usually found in applied mathematics texts: functions of one and several variables (elementary differential and integral calculus, including vector functions), infinite series, differential equations (including a brief summary of the calculus of variations and only a mention of partial differential equations, but with unusually good treatment of boundary-value problems in ordinary differential equations), complex variables (but omitting conformal mapping), and numerical analysis.

The modern cast of the book is demonstrated by an excellent introduction to groups, in which the abstract concept is tied to physical situations. Other associations are well illustrated also, such as the orthogonality of Legendre polynomials being related to the Schmidt orthogonalization of vectors. The concept of function space appropriately seems to underlie much of the presentation, although it is explicitly discussed only briefly.

In this reviewer's opinion, the Laplace transformation is relatively neglected (and is not associated with the Fourier integral). Other readers will have other such criticisms reflecting personal preferences; but every reader should appreciate the authors' lucid writing, which recommends the text for student use.

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The reviewer, a professor of mechanical engineering at the University of Washington, teaches courses in "engineering analysis," which relate the common underlying mathematics of different physical systems.

All the necessary math

MATHEMATICAL METHODS FOR PHYSICISTS. By George Arfken. 654 pp. Academic Press, New York, 1966. $12.75

by J. E. Romain

Here is a book of mathematics for physicists that truly fulfills its purpose. In an alert and dynamic style, it presents all that is necessary of an eclectic variety of mathematical topics that may be useful to a physicist at an undergraduate and beginning graduate level, without unnecessary details. Arfken knows what he is speaking about, as he has been teaching in the field for many years. The exposition is essentially oriented towards application. The motivation and the usefulness of the various concepts introduced are carefully stated. Numerous examples of application of the techniques described are offered, often borrowed from physics. Many problems are posed, a few (too few) of them with an answer or a hint.

The topics reviewed cover coördinate systems, vector and tensor analysis, matrices and determinants, infinite series and products, functions of complex variables, second-order differential equations, special functions, Fourier series, integral transforms, integral equations and calculus of variations. The reader is expected to have a working knowledge of calculus. The arrangement of the material renders the book quite adequate for self-teaching. (The only shortcoming in this respect is the lack of an answer to most problems.) At the end of each chapter a few references are given that should enable the student to dig deeper as necessary. An index of notations would have made the book even more useful to the student who opens it for a definite piece of information. A fairly detailed subject index has been set up, but it still is not fully complete. (In an occasional check, such items as solenoidal and irrotational vectors and Fourier-Bessel series were found to be lacking.)

The book is carefully printed and is pleasant to read and handle. The only slight misprints that the reviewer spotted are a missing constant factor in eq. (5.154) and a repeated (and slightly irritating after the third time) use of "principle" instead of "principal" (pages 272 to 277 and index).

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The reviewer formerly taught theoretical physics. He is presently a scientific adviser in applied mathematics and physics.

Thermo, stat mech and kinetic theory

STATISTICAL PHYSICS. By Gregory H. Wannier. 532 pp. Wiley, New York, 1966. $11.50

by George H. Weiss

This book represents a serious attempt to present the theories of equilibrium thermodynamics and statistical mechanics, together with an introduction to kinetic theory, in a single text. As one might expect for such an undertaking, the results tend to be uneven, with excellent coverage and explanation of some topics, and less satisfactory accounts of others.

The beginning of the book, containing a discussion of the foundations of thermodynamics, is reminiscent in its pace of the volume of Tolman. Partic-

ularly noteworthy are the two chapters devoted to the second law of thermodynamics, the first presenting the author's own work on the subject, and the second presenting both the Carnot and Carathéodory derivations. The introduction and discussion of thermodynamic potentials and their applications is clear and enlightening. Following the section of the book dealing mainly with thermodynamics are several sections that present the different statistics. The Gibbs paradox and its resolution is discussed at some length in a very interesting section. A derivation of Fermi-Dirac statistics is somewhat obscure but that of Bose-Einstein statistics is much clearer.

The material following the chapters just mentioned covers many applications including the imperfect gas, lattice dynamics, the statistics of semiconductors, the two-dimensional Ising model and the theory of dilute solutions. Of these, the treatment of the imperfect gas is short, and good for what it contains. The treatment of topics in solid-state physics is more extensive than is usually found in books on statistical mechanics and reflects Wanner's own research interests at the University of Oregon. Of special interest is the preliminary chapter on theories of magnetism. However, the derivation of the partition function for the two dimensional Ising model is quite difficult and would probably not be too clear to a student who has not come across this material before. The chapter on dilute solutions is very clear and is to be recommended.

The remainder of the book is taken up by accounts of kinetic theory and nonequilibrium thermodynamics. Again, there are very good sections and some that give accounts that would be very difficult to follow from the text alone. In the former category is an account of Kac's ring model, and in the latter is the relaxation-rate theory for Maxwellian molecules. A topic whose absence is to be regretted is the BBGKY hierarchy of equations. The account of Brownian motion is rather abbreviated and would probably require considerable supplementation if used for teaching purposes. A similar criticism can also be made of the treatment of Kubo's formulas and the Onsager relations. In particular the author does not distinguish between α and β variables nor does he indicate that there are restrictions related to these two types of variables.

The strong points of this book are the discussions of the foundations of thermodynamics and statistical mechanics. A serious gap in the applications section is the lack of any account of modern techniques employed in the analysis of the many-body problem. I would recommend this book as a text, because other texts in this field tend to be overly formal. However additional material dealing with applications would be a strong desideratum.

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Nondidactical electrodynamics

PRINCIPLES OF ELECTRODYNAMICS. By Aleksey N. Matveyev, Leon F. Landovitz. 415 pp. Reinhold, New York, 1966. $12.50

by H. J. Hagger

Electrodynamics is a subject title that is by no means as self-explanatory as one might think. On an intermediate level using mostly simple mathematics and vector analysis the text reviewed here covers three subjects: phenomenological electrodynamics, electron theory of matter and theory of relativity. Part 1, on phenomenological electrodynamics, describes the electric and magnetic properties of a substance by the permittivity, the permeability and the conductivity, and starts with the basic equations and definitions. The principles of electrostatics are explained and quite a number of simple applications to practical problems follow. The third chapter deals with the static magnetic field in the more or less usual way. Quasi-static electromagnetic fields, the basis of low-frequency electrotechniques, are treated briefly. The title of the next chapter is somewhat misleading, because, under the heading of "The Generation of Electromagnetic Waves," problems of radiation of such waves, making use of a dipole as a "generator," are discussed. Chapter 6