Int. J. Heat Mass Transfer. Vol. 28, No. 1, pp. 315–316, 1985
Pergamon Press Ltd. Printed in Great Britain

Book Reviews

S. WHITAKER, **Fundamental Principles of Heat Transfer,** Reprint edition, Robert E. Krieger Publ. Co. Inc., Florida, 1983, 556 pp.

THIS BOOK is intended to provide a comprehensive treatment of the fundamental aspects of conduction, convection and radiation at an introductory level; it does so more than adequately.

The text is divided into 11 chapters, covering most aspects of practical heat transfer, as follows:

1. Introduction
2. Steady, one-dimensional heat conduction
3. Two-dimensional, steady heat conduction
4. Transient heat conduction
5. The basic equations of momentum and energy transport
6. Turbulent flow
7. Macroscopic balances
8. Thermal radiation
9. Radiation energy exchange
10. Heat transfer with boiling and condensation
11. Design of heat exchangers

The main text is followed by two useful appendices: Appendix A: Properties of materials (in English engineering system units); Appendix B: Tables of mathematical functions. Nomenclature precedes the text, and author and subject indices close the book. Homework problems and References are given at the end of each chapter.

On the whole, all chapters consist of high quality material, imaginatively presented; and adequate care has been taken to ensure complete theoretical developments and preservation of the scientific rigour.

I particularly appreciate the inclusion of "design problems", at the beginning of most chapters (a total of eight). They serve to illustrate well the practical applications of the subject material, and their detailed solutions are given at the end of the corresponding chapter. Furthermore, several solved example problems have been included throughout the text, and will undoubtedly prove of considerable assistance to both student and teacher. Although most of the material is, of course, conventional, the author has obviously made considerable efforts in reworking and presenting it under a different and interesting light. The text makes for very pleasing reading indeed. The thoughtfulness of the author for the student is also reflected in that whenever mathematical knowledge becomes too demanding, the relevant methods are provided in detail (as for example, methods of solving partial differential equations in Chapter 3). Furthermore, the objective of each chapter is clearly stated at the beginning, immediately setting the scene for what is to follow.

The fact that all heat transfer practitioners use computers nowadays has not been neglected either; and FORTRAN programs are given in the context of the numerical solution of 2-D heat conduction problems.

I found the treatment of radiation (Chapters 8 and 9) unconventional and excellent. It is based on the photon transport equation, illustrating clearly the similarity between radiant energy transport and other transport processes; and providing a sound basis for the analysis of absorption and emission phenomena.

Last but not least, the author cares to suggest in the Preface an outline for an introductory course, consisting of 40 classroom hours of balanced treatment of conduction, convection and radiation. Alternative course outlines providing a more flexible coverage of the material are also discussed in the Preface. Lecturers will certainly find these suggestions most useful.

The text design quality is excellent, the (hardcover) book is very well printed and illustrated, and the sample problems, as well as the homework problems are well thought out and interesting.

In summary, a book that can be thoroughly recommended to both students and teachers of undergraduate and graduate courses in Heat Transfer.

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FRANK M. WHITE, **Heat Transfer.** Addison–Wesley, Reading, Mass., 1984, 584 pp., ISBN 0-201-08324-8, £14.95.

THE BOOK is written as an undergraduate text, and has a traditional organization of material: an introductory chapter, three chapters on conduction, three on convection, and one each on radiation, boiling and condensation, and heat exchangers. There are also tables of mathematical functions and physical properties, and each chapter includes a large number of worked examples and problems, the answers to many of which are given at the back of the book. Although SI units are used extensively, some problems feature Imperial units.

Chapter 2 covers basic one-dimensional conduction, including solutions of the fin equation. In Chapter 3, the general multi-dimensional conduction equation is derived and the 'conduction shape factor' is used to extend classical solutions for conduction in rectangular solids to other geometries. Numerical solutions of Laplace's equation, using finite-difference techniques, are also discussed. The treatment of unsteady conduction in Chapter 4 is less satisfactory. A number of analytical solutions, the proof of which the average undergraduate could readily understand, are stated without proof. In particular, the 'sudden immersion' or 'quenching' problem (that is, Fourier's equation with step-changed convective boundary conditions) can be solved easily by separation of variables; this exercise is worthwhile as it gives the student insight into the use of Heisler charts. Despite the above omissions, the author's extension of the one-dimensional 'quenching' problem to multi-dimensional bodies, by means of the 'product method', is useful. Finite difference techniques are also used to solve Fourier's equation in Chapter 4, although it is surprising to see no reference to the Crank–Nicolson method.

The chapters on convection are disappointing. The boundary-layer equations are derived without an explanation of the substantive derivative: the perplexed reader is referred to one of Professor White's books on fluid mechanics for enlightenment! No mention is made of Reynolds stresses for turbulent flow, and there is no derivation of the Reynolds analogy. The latter can be readily derived using the boundary-layer momentum and energy equations applied to flow over a flat plate: this gives the student an appreciation of the strong links between fluid mechanics and convective heat transfer. Another notable omission is the Blasius solution for laminar flow over a flat plate. With respect to the section on the solution of the momentum integral equation, it should be pointed out that Pohlhausen was the student of Prandtl not of von Karman.

The chapter on radiation is clear and comprehensive, and boiling and condensation are afforded adequate coverage. As