Int. J. Heat Mass Transfer. Vol. 23, pp. 1168–1170
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BOOK REVIEWS

Laser Velocimetry and Particle Sizing. H. Doyle Thompson and Warren H. Stevenson, eds., Hemisphere, U.S.A., 556pp.

This book reports the proceedings of the third international workshop on laser velocimetry held at Purdue University, July 1978. Unfortunately this fact is not made clear in the title. The papers are concerned with the use of laser scattering to measure velocity and particle size.

Since its inception in 1964, the technique of laser velocimetry has gone through considerable development and is now a mature method for the measurement of flow velocity. In contrast, the measurement of particle size using laser scattering is at a relatively early stage of development. As might be expected, the balance of papers in the volume reflects the relative state of development of the two fields with many more successful applications of laser anemometry described than there are of particle sizing.

The papers on laser velocimetry show that the technique can now be fairly readily applied to a wide range of measurements including studies of combustion processes. However, there are still areas yet to be covered, as is shown in the session on internal combustion engines where no measurements are reported of flow in running engines.

The papers on particle diagnostics describe several different approaches to the problem of measuring particle size using laser scattering. The principal emphasis in the papers is on the development of instrumentation rather than its application.

In general, the papers provide a fair picture of the state of the art in laser velocimetry and particle sizing at the time of the meeting. As such, the book can be recommended to those active in the field and to those interested in the application of the techniques described. However, as is the nature of the proceedings of workshops, the volume will be of very limited use to those unfamiliar with the fundamentals of the area.

P. Hutchinson

Chang L. Tien and John H. Lienhard, **Statistical Thermodynamics.** Revised printing, Hemisphere-McGraw-Hill (1979). xvi + 397 pp.

This is a new printing of a textbook which first appeared in 1971 and which enjoyed a measure of success at the time. In the absence of indications to the contrary, it appears that this printing contains no changes compared with the first edition.

The book first appeared towards the end of an era in engineering education, though it must have been written near its climax. This was the time of expansive space exploration when the West believed in unlimited economic growth through the medium of a science-based technology and an increasingly science-oriented industry. The sequence of development appeared incontestable: scientific research followed by discovery, inevitably resulting, via development and demonstration, in new technologies and products.

At that time, statistical thermodynamics was percolating from theoretical physics to graduate and advanced undergraduate curricula in engineering. Tien and Lienhard's book was conceived as a vehicle for that progression and did it well: it takes the student in easy steps from macroscopic concepts through kinetic theory à la Sir James Jeans and classical statistics of independent particles to quantum mechanics. The book contains the standard applications and ends with a chapter on Boltzmann's equation and its solution. The emphasis is on doing, though some space is devoted to 'philosophy', in particular to a discussion of ergodicity in which, quite rightly at this level, the subtleties of the various 'paradoxes' are underplayed.

Since the beginning of this decade, times have changed and curricula emphasize 'energy', 'nuts and bolts' and similar aspects of the more classical topics of thermodynamics. How many universities still include courses in statistical thermodynamics in their *engineering* curricula, I do not know. The ones that do ought to take a look at this book.

Joseph Kestin

Leroy S. Fletcher (editor), **Heat Transfer and Thermal Control Systems.** Vol. 60, Progress in Astronautics and Aeronautics. AIAA (1978). 382 pp.

This book has been published simultaneously with its companion "Aerodynamic Heating and Thermal Protection Systems", Vol. 59, in this series. This book is concerned with: (1) Heat pipes, (2) Complex situations heat transfer and (3) Thermal Control systems. Thermal control systems deals primarily with the heating and cooling problems of space vehicles and their components. More recently, thermophysics has expanded to include, for example, energy collection, conversion and storage, resource assessment by satellite, thermal protection of space vehicles and detection of air and water pollution. The fundamentals of thermophysics are extremely important in the development of new and better thermal control components and systems.

Uniform temperature environment for instruments in the space missions must have precision thermal control. Heat pipes are a widely used but rather intricate means for internal temperature control, and the usefulness and effectiveness of these devices seem to increase each year. In this book basic transport processes and mathematical models in heat pipes are presented. Details on heat pipe geometry, shut-off performance and diode-reversal performance are presented.

A paper summarizes the state-of-the-art of axially grooved heat pipes. Recent developments in the analysis, design and fabrication of axially grooved hardware are discussed. A mathematical model that predicts the hydrodynamic behavior and accounts for liquid recession and liquid–vapor shear interaction is presented. A simplified closed-form solution that accounts for gravity effects, self-priming and composite pumping by the grooves is discussed.

Another paper describes theoretical and experimental results of a re-entrant groove heat pipe with 20 grooves of 0.8 mm dia channel and a 0.2 mm wide passageway.

Performance of a gravity-assisted heat pipe operated at small tilt angle is investigated theoretically, including the effect of vapor shear. The vapor shear creates a backflow region at the surface of the puddle and thereby degrades the heat pipe performance. It is found that, if the fluid charge exceeds a certain amount, the heat pipe operation becomes unstable at a relatively small heat transport.

The decomposition and corrosion of two-phase heat transfer liquids and metal envelopes have been investigated. Potentially stable heat transfer fluids for the temperature range 100–350°C have been identified.

Recent advances in the fundamentals of conduction, radiation and convection are presented also in this book. The analysis of radiative characteristics of materials is of increasing importance. Finite-element method for steady-state thermal analysis of convectively cooled structures is presented. Conduction across material interfaces, specifically thermal contact resistance, is included.

Design details and thermal vacuum test results for a lightweight flexible radiator system for on-orbit cooling of space payloads are given in the third chapter of this book. In addition, flight temperature measurements on geosynchronous satellite thermal control surfaces, space radiation on thin polymers and non-metallic materials have been evaluated.

For those interested in thermal control system designs of satellites, rockets and spacecrafts, this book is a good reference.

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FRANK M. WHITE, **Fluid Mechanics.** McGraw-Hill, New York (1979). 701 pp. Price £13.90.

ALAN MIRONER, **Engineering Fluid Mechanics.** McGraw-Hill, New York (1979). 592 pp. Price £15.75.

McGRAW-HILL published these two books in the same year, 1979, with nearly the same credits (to use a description from the world of cinema): they share a publisher's editor, a copy editor, a production supervisor and the company for drawings. Each is set in Times Roman. Both prefaces indicate that the books are for the same market, that is students in the first year of an engineering undergraduate course. The topics covered are very similar, becoming identical in a number of identically titled chapters. It is not then surprising that glancing through one book is very like glancing through the other. I suppose McGraw-Hill know what they are doing. Mironer's book has the more informative title; White's book, called simply "Fluid Mechanics", is in fact engineering fluid mechanics.

The British student reader (both books are from the U.S.A.), used to a more austere writing style, will raise his eyebrows at, in one preface "the study of fluid mechanics should be stimulating and fun", and in the other "every attempt has been made to make this book teachable (sic), readable and interesting – fun, even". I think his idea of what is fun lies outside the covers of text books, though of course he will relish being interested and stimulated; and both books can claim to do this. Both are planned with the clear, explicit purpose that they will be bought by students and used as the overt specification of the Fluid Mechanics course by the lecturer and the class. Publication list prices show White's book at £13.90 (701 pp.), Mironer's at £15.75 (592 pp.).

Most British students have acquired two stylistic habits which condition their learning experiences and which are ignored by teachers at their peril; they presume that the material given explicitly in lectures is definitively 'the course' and, probably consequently, they buy few books and then only if they are inexpensive. I do not know how to set about altering this, but I wish it could be done. The two books under review are therefore unlikely to be bought by many British students because they fall into that huge category of texts which 'do not follow the course' that the students are taking and they are expensive (in their terms). Students are impoverished by not having, for constant reference in their private study hours, books of the kind so carefully compiled as these two are, so full of detailed material, presenting hundreds of diagrams from which the learner absorbs so much at a glance and containing reproductions of photographs of flow visualizations. Lecturers will find the books provide a splendid source of problems to set to students, White's book having over 1000.

Eulerian Fluid Mechanics is a field theory and consequently the appropriate branch of mathematics for a substantial block of the material is vector field algebra and calculus. Yet to become familiar with the concepts and analytical apparatus of scalar and vector fields requires a course of study to itself, frequently not one that has been given to British engineering undergraduates taking a first course in fluid mechanics. Both authors here under review presume reasonable familiarity with it, White using it considerably more extensively. Many courses in fluid mechanics avoid coming to grips with the meanings of potential flow, vorticity, irrotationality, stream function, circulation etc. Consequently a book like White's *Fluid Mechanics* which introduces these concepts in their natural place in the development of the subject will present many students with insurmountable barriers. It is of course a perennial problem for the lecturer to decide just where to bring in the cut-off in the level of sophistication in mathematical modelling. There are many small decisions which have to be taken all the time but there are clearly two major ones: when do you cross the barrier from the use of the algebra and calculus of single-variable functions and start to use vector field algebra and calculus? When do you cross the next barrier into tensor algebra? Both authors in their texts for a first course cross the first barrier; neither crosses the second, for they both quote without proof the stress–rate-of-strain equations, in Cartesian coordinates, for a Newtonian fluid.

The two texts under review have much in common. Probably the most important distinguishing feature, as already implied, is that Mironer's book contains less material that is dependent on mathematical skills which it is presumed the student has already acquired. He also writes in a more restrained style, which is to this reviewer's taste. White has a habit of introducing unnecessary value judgements which jar. For example in describing the classic problem of inviscid irrotational flow past a circle in a plane he comments that "Inside the circle it (the solution) represents a rather ugly and unrealistic trapped circulating motion". The word "ugly" is entirely out of place. Both authors develop their subject matter in a sequence of chapters based on control volume analysis, Mironer only very briefly touching on the differential equations of fluid flow. Mironer also excludes discussion of the classic field of inviscid irrotational flows. He is good at presenting the student learner with information about real flows, he selects carefully what can be presented simply. Each author includes a chapter on Hydrostatics, leads up to chapters on Internal and External Flows and ends with Turbomachinery, Open-Channel Flow, Compressible Flow as the last three chapters in their texts. Neither author has much to say about the nature of turbulence. To instruct first-year students about the nature of turbulence is a challenge which this reviewer has not yet seen successfully tackled anywhere. It is a formidable task but its absence does leave an awful gap in our teaching.

Either of these books would be valuable aids to a student's study of fluid mechanics provided that his lecturer's course was well coordinated with the book's contents.

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