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REVIEWS

Vector Mechanics of Fluids and Magnetofluids. By SALAMON ESKINAZI. Academic Press, 1967. 499 pp. $16.00 or 128*s*.

Introduction to Fluid Mechanics. By JERZY A. OWCZAREK. International Textbook Company, 1968. 516 pp. $10.95.

The steady stream continues of books intended to introduce fluid mechanics to senior undergraduate and beginning graduate students in the United States. Apparently, every publisher needs at least one in his catalogue; though most must be at least moderately successful from the commercial point of view, one wonders how many of them will, ten years from now, have had any significant influence on the pattern of education in this field. Of the two books reviewed here, one may perhaps achieve this kind of success but the other, almost certainly, will not.

Professor Eskinazi's book is offered as a response to a problem felt acutely by those who have attempted to lecture in fluid mechanics to beginning graduate students, newly arrived from a variety of undergraduate institutions. He writes: 'For most students and in most universities the Bachelor's degree is a terminal degree. Because of this, many undergraduate curricula lack the academic sophistication that paradoxically we request from the same students entering graduate school. Often, since graduate teachers have no contact with undergraduate teaching, the level of proficiency they demand excels by far that given in the undergraduate years.' Accordingly: 'This book has been written with the purpose of providing the student a smoother transition from the undergraduate to the graduate requirements.'

After introductory chapters on 'fundamental concepts'—the physical nature of fluids—and on vector algebra and vector calculus, there is an extensive chapter on fluid statics dealing with the nature of equilibrium, forces on immersed bodies and capillarity. The discussion is detailed and elementary, and generally clear. A notable exception is the section on page 86, 'Stability of Static Equilibrium' (of a *compressible* fluid under gravity) which is, to this reviewer, totally incomprehensible and leads to the erroneous conclusion that the condition for neutral equilibrium is the vanishing of the vertical gradient of density (not potential density, which does not seem to be mentioned in the book). The following chapter on Kinematics is more demanding of the mathematical talents of the reader but still presented in detail, twelve pages being devoted to an analysis of local deformation. The streamfunction is introduced rather vaguely: 'Let ψ be a scalar function in a two-dimensional steady flow representing the geometry of the stream surfaces.' The momentum and energy equations are presented in various forms and there follow long chapters on inviscid fluids, source and sink flows, transformation theory and vortex flows. The last two chapters justify the end of Professor Eskinazi's title, being a quick review of electromagnetism and Maxwell's equations with some simple applications to fluid mechanics.

It is on the whole an interesting book, though it should be used with care. Some things are rather misleading: the section (p. 153) entitled 'Conservation of Vorticity' contains only a demonstration that the vorticity is solenoidal, and a perfect fluid is defined (p. 267) as one of constant volume and devoid of vorticity. There are some surprising omissions, most notably the absence of any systematic discussion of viscous flows or boundary layers, except for the magnetohydrodynamic case. Some of the figures are not all that they should be, the one (p. 297) showing streamlines and potential lines for a pair of equal sources being of astonishing complexity, and, on page 404, a staggered double row of vortices having one set rotating in the wrong sense. Nevertheless, the book has considerable virtues and, usually, a clear logical thread.

Regrettably, this is not so in the second book under review. Written for a first course to undergraduate engineers, its cover promises 'a thorough coverage of fundamentals'. Yet the first chapter (Fundamental Concepts) is a remarkable pastiche of topics that are mentioned without any real attempt at connexion or explanation—the idea of a continuum in a medium consisting of molecules, heat conduction (talking about 'the average speed of the random translating motion'), 'Eulerian' and 'Lagrangian' frames of reference, Coriolis forces, steady and unsteady flows, definition of a fluid, viscous friction and heat conduction (again), Newtonian and non-Newtonian fluids, separation of flow, Kármán streets, Mach waves, cavitation, surface tension, turbulence and the Reynolds experiment, the physical properties of fluids (with extensive tables), then drifting off into fluid statics and Archimedes' principle. After a chapter on similarity methods, the book begins again (on page 101) with kinematics, followed by the equations of motion and integral form: perfect fluids, plane irrotational motion; the Navier–Stokes equations, hydrodynamic stability and turbulence all in one chapter; two-dimensional boundary layers and 'miscellaneous topics'.

Two examples will illustrate the nature of the book as clearly as can any comments of mine. Having shown that the streamfunction in two-dimensional, constant density flow is such that $u = \partial\psi/\partial y$, $v = -\partial\psi/\partial x$, it is shown on pages 141–142 that the vorticity ω equals $-\nabla^2\psi$ in the following way. The author starts with the statement $\mathbf{v}.\nabla\psi = 0$, differentiates with respect to x and divides by u, then with respect to y and divides by v, adds and manipulates to achieve his result. Besides offering a remarkable way of obtaining a one-line result, the page contains at least one error of principle (what happens when either u or $v = 0$?) and one misprint. Again, under the title 'Hydrodynamic Stability' on page 302, the following is presented: 'The instability of flow between rotating concentric cylinders was first studied by G. I. Taylor in 1923. He observed the flow instability in form [*sic*] of closed ring vortices uniformly spaced along the axis of the cylinders. These rings, which can be observed not only when the flow is laminar but also when it is turbulent are called the Taylor instability [*sic*]. When plotted on a graph in which the values on the ordinate axis represent the Reynolds number $Re_i = \omega_i r_i^2/\nu$ and those on the abscissa the Reynolds number $Re_o = \omega_o r_o^2/\nu$ where ω denotes the magnitude of the angular velocity and r the radius of a cylinder while the subscripts i and o refer to the inner and outer cylinder respectively, the limit below which the flow is laminar and free of the instability (non-periodic flow) is called the Taylor stability boundary.' Then six pages of experimental data and photographs by Coles; no indication as to why the instability occurs at all or why only centrifugal forces are involved or indeed how a stability analysis is even set up. If engineers are to be denied a simple analytical discussion of important topics in fluid dynamics (and this reviewer sees no reason why they should) then the least one can ask is for a sound qualitative discussion, for the development of physical insight. I am far from sure that this book offers either. One would, I think, do better by reading Prandtl's older book *Essentials of Fluid Dynamics.*

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