FLUID MECHANICS

By Pijush K. Kundu
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It is commonly accepted that students of physical oceanography should possess a knowledge of the basic concepts, techniques, and theorems of fluid mechanics, upon which they can build an understanding of more particular areas such as geophysical fluid dynamics, ocean circulation and structure, ocean acoustics, estuaries, or whatever. The same is true for students of engineering if their aims are towards the mechanical, environmental, chemical, or aeronautical areas. The applications may well change during a scientific or professional career, but a thorough understanding of the fundamentals is common to them all. Most texts concentrate either on these or on one or other of the areas of application; Kundu's book, intended for students of both engineering and geophysical fluid dynamics, is unusual in that it seeks to cover not only the basic areas but also instability and turbulence and extensions into geophysical fluid dynamics, aerodynamics, and compressible flow.

It assumes no prior knowledge of the subject, starting with the static properties of fluids, digressing into a summary of Cartesian tensors before the chapter on kinematics. Curiously, we read here about the stream function before mass conservation is derived formally in the next chapter on conservation laws, but then, chapters cannot always fit neatly together. There is a good, though short, chapter on vorticity dynamics which might have been improved by some illustrations of vortex stretching in dust devils or bathtubs. One little insight that we tend to forget is given: in a viscous fluid in irrotational motion, the viscous stresses are nonzero, though their divergence does vanish. The viscous term disappears from the Navier-Stokes equation, though energy is dissipated. The chapter on irrotational flow is rather standard (the student may find it hard to maintain enthusiasm here) and leads into a discussion of surface and internal gravity waves. Dynamical scaling and similarity appear in Chapter 8 (this might have been better placed earlier) and the "basic" sections of the book conclude with chapters on laminar and boundary layer flows.

The part on instabilities includes short but generally clear accounts of the best-known examples: thermal, double-diffusive, Kelvin-Helmholtz, and parallel flow instability. Turbulence is covered in sixty pages or so, with not only the Reynolds averaging formalism and ideas of spectra but also notions of self-preservation and coherent structures. The treatment is careful and should hold the reader's interest—it is one of the few at this level that is critical but fair about ideas of eddy viscosity. The long chapter on geophysical fluid dynamics, an area clearly close to the author's heart, is probably the best in the book—a good introduction to the works of Pedlosky and Gill. The closing chapters on aerodynamics and compressible flows are perhaps less satisfying. An engineer will find them too cursory and an oceanographer probably will not read them at all.

Nevertheless, as a first text in fluid mechanics, this is better than most which have appeared recently. The writing is generally clear though a grammarian might fret about dangling participles. Oceanographers, if reading it selectively, should find it illuminating and valuable. ❑