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Book Reviews

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Fluid Mechanics, 3rd Edition

Pijush Kundu and Ira Cohen, Elsevier, Amsterdam, 759 pp., 2004, $74.95

It is quite useful to read the preface to the second edition (by Ira Cohen) to appreciate and understand the context for this large text (759 pages inclusive of appendices and index). The first edition, the sole work of the now deceased first author, Pijush Kundu, was written from the perspective of an oceanographer. Professor Cohen was added as a coauthor for the second edition that was not completed before the untimely death of Prof. Kundu. As clarified in the preface, Prof. Cohen has added to numerous portions of the text but not to the essentially oceanographic portions: gravity waves, instability, and geophysical fluid dynamics. Further changes are present in this third edition. This text has been prepared for the first graduate course level and, as indicated in the introductory comments, there is clearly sufficient material for a two-course sequence.

The first three chapters (Introduction, Cartesian Tensors, Kinematics) provide conventional material and will likely be found to be (at a minimum) satisfactory as the base material for a course at the intended level. The fourth chapter (Conservation Laws) gives promise of a useful extension to basic control volume (viz. deformable control volumes) formulations, but it fails to be realized beyond Leibnitz's theorem. The fourth chapter provides a blended presentation of control volume and field equations, which, in principle, can be justified, but the utilization of these equations is so different that it seems flawed pedagogy to conjoin them as presented in this chapter.

Chapter 5 utilizes the title "Vorticity Dynamics," which, more properly, could be termed "vorticity kinematics." This relatively short chapter predominantly deals with the inviscid condition. It does include the noninertial and the nonbarotropic contributions in the vorticity transport equation (5.30) with useful discussions of the separate terms although viscous effects are given minimal attention.

Chapters 6, 8, 9, and 10, entitled Irrotational Flow, Dynamic Similarity, Laminar Flows, and Boundary Layers and Related Topics, respectively, can be expected to meet the basic instructional objectives of a first graduate course. Chapter 8, inclusive of the Pi theorem, appropriately begins by inferring the Reynolds and Froude numbers from the governing equation. It does not further state that no new parameters are added with a condition of turbulent flow. The chapter is relatively short (14 pages), which perhaps does not proportionally represent the importance of the subject. Chapters 9 and 10 offer standard topical items.

Chapter 7, Gravity Waves, is a relatively long chapter that reflects a central interest of the first author. This is clearly a strength of the text but one, perhaps, of lesser interest to the readers of the *AIAA Journal*. Information on atmospheric internal waves can be gleaned from this chapter, but the focus is on waves in water. Chapter 11 (by H. Hu) is presented as an introduction to computational fluid dynamics. The topic is well placed in an introductory text given the importance of the subject. However, the topical areas of this chapter do not attempt to review the more common areas of interest such as grid generation, DNS/LES/RANS, turbulence modeling, and experimental validation issues. Rather, the chapter deals almost exclusively with the intimate details of finite difference and finite element methods. It is a relatively long exposition that is out of place in the context of the book. In addition, many of the figures of this chapter became the subject of computer gremlins that led to the presentation of black rectangles rather than the intended information.

Chapters 12–16 cover Instability, Turbulence, Geophysical Fluid Dynamics, Aerodynamics, and Compressible Flow. Each chapter presents a well-written and reasonably comprehensive introduction to the respective subject. These topics are usually too specific for coverage in an introductory fluid mechanics course. More often each of these subjects is offered as a standard or special-topics course in a graduate program. The inclusion of these chapters in a single introductory text allows significant extended study for a motivated student and provides a well-balanced reference for those who may seek a quick introduction to a topic outside of one's core research area.

A distinctive characteristic of this book is that it presents fluid mechanics at a graduate level in a presentation that is not substantially more sophisticated than a typical undergraduate text. In the majority of cases, the figures do not add to the sophistication level of the text and, in some cases, are misleading. Figures 3.18, 4.20, 7.23, and 9.1 are some in which the experienced "fluid mechanics eye" should have overruled the graphic artist's representation. Other figures simply pass up the opportunity to more precisely represent the fluid motion. In these, computed, vs sketched, streamlines of images with a greater fidelity to the fluid motion would be preferred for a graduate text. Equally disturbing is the presentation of quantitative information (e.g., Reynolds stress across a jet, Fig. 13.15) without a numbered scale on the axes.

Readers from a variety of backgrounds may welcome the informal approach. Instructors in the oceanographic and atmospheric sciences may find this to be the only book that covers both the basics of fluid mechanics and these more specialized areas. However, instructors of a first graduate fluid mechanics course in traditional mechanical or aerospace degree programs may find this book to be less rigorous than, for example, Panton's book *Incompressible Flow*. For these readers, it is anticipated that the Kundu and Cohen volume will find more use as a reference than as a course text.

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