Available online at www.sciencedirect.com
ScienceDirect
Journal of Sound and Vibration 309 (2008) 347–348
JOURNAL OF SOUND AND VIBRATION
www.elsevier.com/locate/jsvi

# Book Review

**Hydrodynamics and Sound, M.S. Howe, Cambridge University Press, Cambridge (2007). 463pp., £50, US$95, Hardback xv + , ISBN: 0521868629**

This book covers the subject material ‘‘Hydrodynamics and Sound’’, in a clear and concise fashion. The emphasis is on developing mathematical techniques and using them to solve simple model problems. It would make an excellent graduate level text for students specializing in Marine Engineering, Ship design or Navel Architecture. I found it to be clearly written and, for the most part a pleasure to read. It is remarkably free of errors and contains many well thought out problems and interesting examples to illustrate the general results. However, the preface claims that its intent is to describe the ‘‘generic body of knowledge’’ and ‘‘most important theoretical methods’’ that apply to ‘‘most branches of fluid mechanics’’. But, very few, if any, of the methods that are actually covered would apply to such branches as transition and turbulence—which are arguably the most ubiquitous aspects of the subject. There are other methods such as statistical techniques, formal asymptotic approaches (covered in the book by Zeytounian [1], which is in many respects the exact opposite of the present work) and rapid distortion theory that find application in these areas and are not even touched on in this book. There is also very little that would apply to Supersonic/Hypersonic flows. And, there is virtually no introduction! It starts right off with ‘‘Consider a fluid that can be regarded as continuous and locally homogeneous…’’. Professor Howe certainly can't be accused of beating around the bush here.

The first 4 chapters are based on the author's graduate course in Fluid Mechanics. The first of these contains a brief derivation of the Navier–Stokes equations, which is a little more ad hoc than it needs to be, but is otherwise nicely done and easy to follow. It also discusses (in some detail) the implications of decomposing the motion into its strain and rotational components. The rest of these chapters are restricted to incompressible flows. Chapters 2 and 3, which constitute 40% of the book, are devoted to inviscid (irrational) flows. General theorems and technique are emphasized. The derivations, which tend to be based on quasi-physical as well as mathematical arguments, are usually very clear—sometimes even elegant—and easy to follow. But, it seems a little incongruous to use results in Sections 3.8 and 3.9 on steady airfoil theory before they are developed in Section 3.12 on unsteady airfoil theory. A similar comment can be made about using a formula from Chapter 4 to evaluate the lift on unsteady airfoils in this latter section—which also seems to be somewhat less organized and not quite as elegant as the previous sections on steady flows.

Chapter 4 brings in the effects of viscosity but, except for the very brief Section 4.47, no analysis of the boundary layer flows (where viscous effects are most important at high Reynolds numbers) is given. And turbulence is only very briefly discussed in Section 4.46! The chapter is mainly concerned with rotational flows with the emphasis being on deriving general formulas for overall forces and moments (in terms of the specific Impulse and Kirchhoff vectors) and, to a lesser extent kinetic energy and far-field behavior. These generic results involve terms that can in principle only be evaluated by solving the complete flow problem—which can be very difficult for unsteady viscous flows. But Professor Howe calls on his own extensive research experience to show how these terms can sometimes be evaluated from (approximate or exact) solutions to simple model problems—especially at moderately large Reynolds numbers. The derivations are again very clear, and usually easy to follow. But the algebra now tends to be more tedious (and, therefore, less elegant) than it was in the previous chapters. This is especially true in Section 4.5.2, which derives an expression for the forces acting on solid bodies. The final formula also appears to be somewhat unwieldy. Considerable attention is given to unsteady flows with most of the attention being devoted to motions with strong (2-D or axisymmetric) symmetry. But the many illustrative examples give considerable insight into how this limited class of flows can

doi:10.1016/j.jsv.2007.01.038

be used to develop useful models of real engineering interest. Section 4.5.7, which seems to be more descriptive than the previous sections of this chapter, brings in a model taken from the author's own research on the drag produced by the vortex shedding from a sphere. The modeling tends to be more ad hoc here and it is a little disappointing that no data comparison is given.

Chapter 5 is concerned with free surface gravity waves. The style is now completely different from that of the previous chapters. Various simplified models—most of which have been extensively studied in the literature—are developed by using relatively ad hoc arguments. More rigorous/elegant arguments would certainly be possible here. Formal asymptotic methods, except for the very classical stationary phase/steepest decent methods (which are also developed in a somewhat ad hoc fashion), are studiously avoided. It would have been easier for the reader to appreciate the enormous generality of some of the results (which are only hinted at in Section 5.11.3) if just a few modern asymptotic techniques were brought to bear. But, this chapter places a lot more emphasis on physical interpretation of the results than the previous chapters. It starts out by solving a number of simplified problems and progresses to more complex flows. It does a nice job of exploiting the mathematics to obtain useful information about the behavior of real surface waves. However, example 2 (on refraction of sound by wind) and example 1 (on the pendulum of varying length) seem out of place here.

The final chapter is an introduction to relatively classical acoustics. The emphasis is on long wave acoustics where compressibility effects are weak and only become important at large distances from the source. This is, however, entirely consistent with the rest of the book which only considers incompressible flows. It is somewhat ironic that mean flow interaction effects (which usually become more important at high Mach numbers) are only discussed in Chapter 4. Most of this chapter is concerned with duct acoustics, which has considerable application to muffler design. I was impressed by the large number of practical results that could be obtained by using only very simple mathematics.

Finally, the focus of this book is low Mach number relatively inviscid fluid mechanics. And Professor Howe has done a nice job of covering the subject within this limited context.

## Reference

[1] R.Kh. Zeytounian, *Asymptotic Modelling of Fluid Flow Phenomena*, Kluwer Academic Publishers, Dordrecht, Boston, London, 2002.

M. Goldstein
*NASA Glenn Research Center, Cleveland, OH 44135-3191, USA*
*E-mail address:* marvin.e.goldstein@grc.nasa.gov