REVIEWS

Applied Hydrodynamics. By H. R. VALENTINE. London: Butterworth's Scientific Publications, 1959. 272 pp. 50*s*.

In the preface the author states that the book is intended 'as an introduction to Hydrodynamics for students of Applied Mathematics and as a course in Fluid Dynamics for senior and post graduate students in Civil, Mechanical and Aeronautical Engineering'. He also states that 'the book has a bias towards practical application' and that 'particular attention has been paid to the provision of detailed physical explanations'.

Broadly speaking, it can be said that the author has written a book which is suitable for senior engineering and applied mathematics students as regards level and treatment, but there are serious omissions in the subject matter. Each aspect is taken slowly and illustrated by worked examples. From a mathematical stand-point the treatment is reasonably rigorous and the physical background is kept well in mind. References are given to further reading and there is a list of problems (with answers) at the end of each chapter. The book is limited to incompressible flow and, apart from a short chapter on the effects of viscosity, is mainly concerned with the irrotational flow of an inviscid fluid in two dimensions. It is attractively produced, being well illustrated with diagrams, and the use of headings in heavy type makes it easy to find any particular subject.

Chapter 1, headed 'The flow of an ideal fluid', introduces a variety of topics, including fluid properties, continuity, stream lines, streak lines and path lines (or filament lines), rotational and irrotational flow, the stream function and velocity potential, Laplace's equation, flow nets, Euler's equation for inviscid flow, Bernoulli's equation and its applications. The treatment of these topics is in keeping with the author's intentions and is generally satisfactory, but Kelvin's theorem (relating to the circulation in a circuit moving with the fluid) should have been proved after the derivation of Euler's equation for inviscid flow. There is only a passing reference to this important theorem in a later chapter.

Chapter 2 is entitled 'The flow of a real fluid' and deals with the effects of viscosity, with the distinction between laminar and turbulent flow, and with boundary layers. Results for velocity distributions are quoted and not derived, which is unconvincing for the student. I consider this the least satisfactory chapter in the book, largely because too little space is devoted to it, with the result that the discussion of the various themes is inadequate. For instance, in dealing with stresses in a viscous fluid there is no reference to the deformation of a fluid element and the rates of strain. A fuller discussion of the laminar and turbulent boundary-layer flows, from both theoretical and experimental aspects, would have helped this chapter very much, and the derivation of the two-dimensional equation of motion might have been given in an appendix. These modifications would require a good deal of space and it might be argued that such a treatment is outside the scope of the title of the book, but the book is intended for engineers who have to deal with real fluids; in any case, where a problem can be treated by inviscid flow methods it is important to understand why this is so!

Chapter 3, on 'Graphical flow nets, numerical analysis and experimental analogies', is a very welcome chapter which is quite well done. There is a variety of examples of the appropriate construction of flow nets by graphical methods and a short account of the solution of Laplace's equation by numerical methods. There is a useful account of the membrane analogy and of Hele-Shaw's viscous flow analogy, but more space should have been given to the electrical analogy. This is the most useful analogy for engineers, since it is capable of yielding fairly precise quantitative information and it can be applied to a wide variety of problems.

Chapter 4 deals with the 'Standard patterns of flow'. There are both graphical and analytical treatments of the elementary flows such as source, sink, doublet, point vortex and the combinations with a uniform stream. The concept of circulation, which is introduced here for the first time in the book, would have been much better placed in the first chapter of the book.

Chapters 5 and 6 are headed 'Conformal transformation' and together occupy about one-third of the book. Chapter 5 introduces complex numbers and functions of a complex variable leading to the solution of Laplace's equation in two dimensions. There is a reasonable account of analytic functions and of singular points, but, surprisingly, nothing is said about multi-valued functions, the need to ensure a point-to-point correspondence between corresponding regions of the various planes, and the use of 'cuts' or Riemann surfaces. This I regard as a grave defect, since in my experience this is where engineering students often have difficulty. The potential functions for the elementary flows are established in this chapter, and, finally, the Joukowski transformation is used to derive the flow about a normal flat plate and the Joukowski family of aerofoils. The chapter ends with an account of the lift on a two-dimensional aerofoil. I think it is a pity that the pressure distribution round an inclined flat plate at a small angle of attack was not dealt with in detail, because this is fundamental to the understanding of flow past an aerofoil. Chapter 6 is devoted to flows involving straight boundaries. The Schwarz–Christoffel theorem is stated and its meaning is explained. It is then applied to the mapping of semi-infinite and infinite strips and a number of flows involving straight boundaries are dealt with in detail. These include sink flows in infinite and semi-infinite channels, the flow past a normal flat plate and the flow into a rectangular channel. Finally, an account is given of free streamline theory and there are examples of its application, including the flow through a slot in a plane wall, Borda's mouthpiece and flow past a normal flat plate.

The last chapter is headed 'Three-dimensional irrotational flow'. It is really devoted to axisymmetric flows, and it begins by developing the equation of continuity and the equations governing the stream function and velocity potential for cylindrical and spherical polar co-ordinates. The elementary flows are then developed and followed by their combination with the flow due to a uniform stream. Lastly, there is a short account of the numerical analysis of axisymmetric flows.

At the end of the book there are three appendices, one on the theorems of Green, Stokes, Cauchy and Blasius (to which Kelvin's theorem might have been added), one on exponential, trigonometric and hyperbolic functions (useful although hardly necessary), and one summarizing the main relations and equations governing the flow of an inviscid incompressible fluid.

In addition to the omissions I have mentioned under various chapter headings, there are two others which I regard as very important in a book at this level intended for engineers. First, I should like to have seen some account of the approximate methods which are used in aerofoil theory; for example, the development of fairings using continuous distributions of sources and sinks, and the development of camber line theory using the concept of a bound vortex sheet. Secondly, there should have been an account of vortices in three dimensions, together with their application to the theory of wings of finite span.

My conclusions are that as a text-book on applied fluid dynamics it is too narrow in the selection of subjects, particularly for mechanical and aeronautical engineering students. A number of practically important aspects of inviscid incompressible hydrodynamics have not been dealt with and the effects of viscosity merit a more detailed and comprehensive treatment. On the other hand, there are useful aspects of the subject which have been dealt with and which are not usually found in text-books. The level and treatment of the subjects selected are entirely suited to the students which the author had in mind and there is much in the book which will be of great value to them, even though it cannot be regarded as a comprehensive text-book for a course in incompressible fluid dynamics.

J. H. PRESTON

The Potential Theory of Unsteady Supersonic Flow. By J. W. MILES. Cambridge University Press, 1959. 220 pp. 45*s*.

This book is the eleventh in the series of Cambridge Monographs on Mechanics and Applied Mathematics (edited by G. K. Batchelor and H. Bondi) to be issued, and is in a sense complementary to the monograph by Ward on *Linearised Theory of High-Speed Flow* which was published some time ago. Whereas, however, many books have been written on high-speed steady flow, no comprehensive treatise exists on the theory of unsteady flow. For this reason this monograph will be welcomed by all who are concerned with flutter problems which require a knowledge of unsteady aerodynamic forces at supersonic speeds. It supplements the general information on unsteady flow problems included by I. E. Garrick in Section F, entitled 'Nonsteady wing characteristics', of Vol. VII of *High Speed Aerodynamics and Jet Propulsion*, by A. T. van de Vooren in an article on 'Unsteady aerofoil theory' published in Vol. V of *Advances in Applied Mechanics*, and by G. Temple in a chapter written for *Modern Developments in Fluid Dynamics: High Speed Flow*. Related information is also to be found in comprehensive treatises on aeroelasticity by R. L. Bisplinghoff, H. Ashley and R. L. Halfman and by Y. C. Fung. In addition, a recent series of papers on unsteady transonic flow theory by M. Landahl contains much valuable information. There still remains, however, a need for a comprehensive account of unsteady subsonic theory.

The present monograph is mainly concerned with supersonic flow and only draws attention to corresponding subsonic solutions where comparison is of value in giving further information on the problem. It starts with a discussion of the basic assumptions made in the development of the linearized equations used in the theory, and the validity of various approximations are considered by extending the method of analysis used by Lin, Reissner and Tsien in their classic paper on two-dimensional non-steady motion of a slender body in a compressible fluid (*J. Math. Phys.*, 1948). Then follows a discussion of various transformations which have been used in subsonic theory and it is shown how similar methods can be used in the theory of unsteady supersonic flow. Supersonic problems are much simpler than those of subsonic flow because the effect of the wake can be neglected when the component of flow normal to the trailing edge is supersonic. In many cases exact solutions can be obtained, and four chapters are devoted to a discussion of such solutions. For many of the problems alternative solutions exist but most of those described are due to the author who has made very many important contributions in this field of research.

The chapter on slender wing methods and their application to unsteady flow problems is fairly comprehensive and is a most valuable part of the monograph. In the following chapters solutions are obtained for oscillating delta wings, low aspect ratio rectangular wings and slender non-planar bodies. The monograph concludes with a brief discussion of non-linear problems, and reverse flow theorems are discussed in the Appendix. A very extensive and useful list of references is included.

The monograph is an authoritative account of the subject and one that should be studied by all interested in unsteady supersonic flow theory.

W. P. JONES

Proceedings of the Sixth Midwestern Conference on Fluid Mechanics. The University of Texas, 1959. 465 pp. $12.50.

The above conference and the Fourth Midwestern Conference on Solid Mechanics were held simultaneously at the University of Texas in September 1959, and copies of both sets of proceedings are now available. The original typescripts and drawings submitted by authors have been reproduced photographically, which certainly makes for speed of publication although not for attractiveness of appearance. The volume on fluid mechanics contains 29 contributed papers and the text of an invited lecture by S. F. Schaaf on rarefied gas dynamics.