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# REVIEW

**An Introduction to Viscous Flow.** By W. F. Hughes. McGraw-Hill, 1979. 219 pp. £13.95 (hard cover).

This unpretentious volume provides an introduction to viscous flow theory, and although intended for students of engineering it may usefully be read by anyone who has attended a first course in fluid mechanics devoted to inviscid flow theory. The first, brief, introductory chapter sets the scene with a discussion of Eulerian and Lagrangian co-ordinates, and the balance laws for conservation of mass, momentum and energy. The no-slip condition is stated and described as a 'fundamental concept' but, surprisingly, is not the subject of any further elaboration. At the beginning of the chapter the reader learns that the terms viscous flow and laminar flow are to be used interchangeably so that the term viscous laminar flow is redundant. The adoption of this convention is unfortunate, and leads to some subsequent confusion. The second, and longest, chapter is devoted to incompressible flows. It begins with a discussion of one-dimensional flows for which the simple governing equations are derived as required, and ends with a description of certain types of non-Newtonian fluids. The bulk of the chapter is devoted to a derivation of the equations of motion, with a full discussion of the stress and deformation tensors and the stress–rate-of-strain relationship for a Newtonian fluid. The energy equation is not derived until chapter four where simple solutions for one-dimensional flows are also presented. Both these chapters emphasize that in a study of compressible fluid flow the energy equation is required and 'perhaps an equation of state'. The necessity for an equation of state becomes apparent in subsequent chapters. Chapter three is concerned with problems of hydrodynamic lubrication theory. The neglect of low-Reynolds-number flow past a finite body, which is a rich source of mathematical problems, betrays the engineering bias of the book. The final two chapters are devoted to high-Reynolds-number flows, with the last chapter itself concerned with thermal effects in boundary layers in both forced and free convection. The penultimate chapter on incompressible boundary-layer flows contain a short section on turbulent boundary layers, otherwise it is concerned with a derivation of the boundary-layer equations and the momentum integral form of these, with applications to the classical semi-infinite flat plate and stagnation-point flows. An over-emphasis of the importance of approximate methods based upon the momentum-integral equations and similarity solutions, together with a neglect of recent developments in our understanding of flow separation (although the mathematical complexities of these are beyond the scope of the book) give the book a somewhat 'dated' appearance. Nevertheless the book achieves its limited aims, is well produced and relatively free from misprints. Amongst the latter the most serious mathematically is that which attributes the boundary conditions at the origin for the Blasius equation to a vanishing of tangential velocity and stress at the boundary, whilst the most serious aesthetically (although Schlicting (*sic*) might take issue with this) postpones by one year Prandtl's seminal paper of 1904.

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