J. Fluid Mech. (1985), *vol.* 151, *pp.* 498–501

REVIEWS

Nonlinear Waves. Edited by L. DEBNATH. Cambridge University Press, 1983. 360 pp. £20.00.

This book comprises photographic reproductions (from uniformly typed copy) of the papers presented at the research conference on Nonlinear Waves and Integrable Systems at East Carolina University in June 1982. It is divided into three parts: Nonlinear Waves in Fluids (7 papers, 132 pp.), Nonlinear Waves in Plasmas (5 papers, 124 pp.) and Solitons, Inverse Scattering Transform and Nonlinear Waves in Physics (6 papers, 111 pp.), plus the Editor's Preface and a combined author-and-subject index. The authors and titles of the papers in the first part are:

1. Longuet-Higgins, M. S. Towards the analytic description of overturning waves;
2. Johnson, R. S. The Korteweg–de Vries equation and related problems in water-wave theory;
3. Grimshaw, R. Solitary waves in slowly varying environments: long nonlinear waves.
4. Shen, M. C. Nonlinear waves in a channel;
5. Moroz, I. M. & Brindley, J. Soliton behaviour in models of baroclinic instability;
6. Bryant, P. J. Waves and wave groups in deep water.
7. Craik, A. D. Two- and three-wave resonance.

I found each of the above papers to be interesting and of high quality; however, as far as I could judge, almost all of the material in them either has appeared or will appear in archival journals. This might not be objectionable if the papers had been organized to present an ordered picture of nonlinear waves (cf. *Nonlinear Waves*, ed. S. Leibovich & A. R. Seebass, Cornell, 1974), but the field now has grown much too large for such a presentation in a book of the present size. And, in any event, no editorial ordering or even (as far as I could tell) cross-referencing has been attempted here, despite the Editor's "hope that this monograph brings together *all* of the most important, recent developments in the mathematical theory and physical applications of nonlinear waves and solitons in fluids and plasmas, besides describing *all* major current research on the inverse-scattering transform" (emphasis added).

What, then, is the justification for the present book? I can imagine answers to this question, but none that is acceptable. What we have is simply another conference volume to drain the hard-pressed budgets of our libraries and gather dust on their shelves. And, to add insult to injury, from perhaps the most respected publisher in the world of science!

JOHN MILES

The Applied Dynamics of Ocean Surface Waves. By C. C. MEI, Wiley-Interscience, 1983. 740 pp. £66.75.

The first duty of a reviewer is to describe the contents of the book he is reviewing. When the book is over 700 pages long, that leaves little room for further comment in a review limited to 1500 words. Fortunately in Chiang Mei's book, which is not a textbook, but rather a collection of self-contained topics broadly covered by the book's title, the choice of, and emphasis placed on, each topic is everything.

Chapter 1 is the shortest of all, in which the basic ideas on surface waves are developed in a standard way. The brevity of this opening chapter is a measure of the enthusiasm of the author to press on to the weightier material that follows.

Cauchy–Poisson problems are classical unsteady water-wave problems with a long history. Typically such problems seek the temporal and spatial development of the water-surface elevation after an initial localized impulse is applied. In chapter 2 the author tackles various generalizations in both two and three dimensions, including the development of tsunamis due to transient disturbances originating on the sea bed. Much of this material appears new, and the development far exceeds previous treatments in comparable texts.

Refraction, or the changes in amplitude and phase velocity of waves as they propagate over a varying bottom topography, or ride on currents of varying strengths, is the theme of chapter 3. An approximate ray or geometrical-optics theory is developed and illustrated at length by simple examples having parallel and circular depth contours. The major shortcoming of ray theory is its failure to predict reflection. This can be overcome by the use of an ingenious model equation, called the mild-slope equation, which embraces both diffraction as well as refraction effects. It would have been interesting to see the accuracy of this equation by considering a simple case, perhaps at the expense of one of the ray-theory examples. The final part of the chapter concerns the interaction of waves and currents. The author's derivation of the basic equations extends the WKB formalism which was used earlier in the chapter in deriving the evolution equations for refraction by a changing bottom topography. This section is particularly heavy-going, but the reader is rewarded by some interesting examples amply illustrated.

When abrupt changes in bottom topography occur within a wavelength, the methods described in chapter 3 are no longer applicable, since appreciable scattering of incident waves occurs. Chapter 4 considers such problems under the simplifying assumption that the waves are long and of infinitesimal amplitude. The author concentrates in some detail on wave scattering by a straight depth discontinuity, where the solutions are exponentials. A fairly standard discussion of trapped waves over a submerged ridge using ideas from quantum mechanics is followed by an application of the parabolic approximation to waves incident upon slender discontinuities in depth profiles and to general wave interactions with slender obstacles. The author is refreshingly candid in his criticism of the validity of his own early results following checks against full numerical solutions (p. 167).

The chapter ends with a valuable discussion on numerical methods for complicated bottom topography. Considerable detail is given, making the material suitable for direct application to particular configurations. The example provided, of the response near the Hawaiian islands to tsunamis caused by earthquakes, showing excellent agreement between theory and records, justifies the painstaking description of the technique.

The amplitude of the resonant oscillations within a harbour due to periodic forcing at the harbour mouth is limited by a variety of mechanisms. Chapter 5 is concerned with one of these – radiation damping, or the leakage of energy seawards from the harbour mouth. For harbours of simple shapes with narrow entrances, the techniques of matching of eigenfunctions and matched asymptotic expansions yield good approximate results for the resonant responses, as the author has shown in a number of joint papers. Many of these results are described here, and although each problem has distinct features of interest, the chapter would have benefited from a broader coverage of the whole subject, including, for example, a description of Miles' equivalent-circuit analysis (*J. Fluid Mech.* **41**, (1971) 241–265), which is mentioned as a supplementary reference but finds no place in the text.

In the short chapter 6 an attempt is made to model more realistically the actual flow behaviour through a narrow harbour wall or a perforated or slotted breakwater, using in the near field a semi-empirical friction loss formula which is quadratic in the local velocity, and matching this with the shallow-water equations in the far field.

The long chapter 7 is concerned with the dynamics of floating bodies, and the development is similar to chapter 6 of J. N. Newman's *Marine Hydrodynamics* (MIT Press, 1977) but pitched at a higher level. There is a strong emphasis on numerical methods, which are essential in this field except for the simplest of body shapes where analytical solutions are possible, but this reviewer was disappointed to find no reference to the fundamental pioneering work of Ursell on two-dimensional problems involving barriers and half-immersed circular cylinders. It is arguable that his 'multipole' technique, applicable to cylindrical geometries, remains the most accurate method for two-dimensional problems and is a valuable yardstick for more general methods. The global identities derived by Haskind–Hanaoka and Bessho–Newman between radiation and scattering problems are given due prominence and put to good use in a section on the hydrodynamics of devices for extracting energy from waves. A section on the transient motion of a floating body is particularly welcome, since previous complete treatments are not easily available, although the results are widely used.

In chapter 8, theories for wave damping due to viscosity are developed, illustrated by the case of standing waves in a circular basin. There follows an interesting section (due to Dore) on the effect of air on the damping of deep water waves, where it is shown that the viscous attenuation due to the air above the water surface can, in some cases, be more important than the dissipation within the water itself. The chapter ends with a discussion of the turbulent boundary layer near a rough bottom.

Chapters 9 and 10 are concerned with currents induced by wave motions. In chapter 9 the mass transport in the boundary layer near the sea bottom is studied when the wave field above is essentially invisid and irrotational. The phenomenon of steady streaming near a solid wall next to an oscillating fluid has been known in acoustics for over one hundred years, but it was not until 1953 that Longuet-Higgins provided an explanation for the same phenomenon in water waves. Here the author presents a general treatment applicable to any oscillatory flows, with water waves being a special case. Applications include bottom mass transport under a long-crested wave and sediment accumulation near a circular pile.

Longshore currents and their effects are considered in chapter 10. The important idea of radiation stress representing the time average of the local horizontal momentum flux is developed in a systematic manner, ending with a useful summary of the results in a number of interesting special cases.

The long chapter 11 is a self-contained exposition of nonlinear shallow-water theory in terms of two fundamental parameters: the depth to wavelength ratio and the wave amplitude to depth ratio. A systematic exploration of their relative magnitudes leads in turn to the simple Airy theory for very long waves of finite amplitude and the Boussinesq theory for weakly nonlinear waves of moderate amplitude. Examples based on the Airy theory include non-breaking wave run-up on a beach, and an illustration of subharmonic resonance in which a standing edge wave is resonated by a normally incident wave of double frequency. This is followed by a section on the solitary and cnoidal permanent-wave solutions of the Boussinesq equations, which leads naturally to the Korteweg–de Vries equation describing the more general transient evolution of nonlinear dispersive long waves.

The subject of nonlinear waves in deep water has received considerable attention in the past few years. In chapter 12 the author contents himself with a good introductory summary of the various directions of research together with appropriate references followed by a description of a few specific topics. These include the derivation of the cubic Schrödinger equation for slowly modulated weakly nonlinear waves in moderate depths; classical Benjamin–Feir instability; the important numerical work of Yuen & Lake; recent joint work by the author and D. K. P. Yue on the diffraction of steady Stokes' waves by a thin wedge, and a consideration of second-order forces on a full body. This last section, which is a detailed working of a paper by Molin, will go a long way towards settling the various disagreements that have arisen amongst several workers about this problem. The chapter concludes with a description of the effecient numerical techniques, originated by Longuet-Higgins & Cokelet and developed by others, notably Vinje & Brevig, for calculating the time development of a plunging breaker.

The final chapter stands apart from the rest and reflects one of the author's current interests, which is in wave-induced stresses in a poro-elastic seabed. The chapter begins with an account of the basic equations of a deformable porous medium. These are linearized, and a boundary-layer approximation appropriate near the 'mudline' developed. Specific examples treated include the bottom stresses due to a progressive ocean wave and the response to a localized oscillating pressure.

The book ends with an extensive list of references, including, usefully, many papers that are not specifically referred to in the text.

It was with a certain amount of trepidation that this reviewer took on the daunting task of reviewing a book of such length and of such apparent mathematical complexity. To quote from the author's preface, "The aim of the book is to present selected theoretical topics on ocean-wave dynamics, including basic principles and applications in coastal and offshore engineering...". An unsuspecting offshore engineer would be forgiven for thinking, on a brief inspection, that whatever the aim, the direction lay firmly in the realms of higher mathematics. On closer inspection, however, he (or she) would be forced to admit that the author does succeed, despite such details, in illustrating the theory with relevant and interesting applications and the reader will find the examples discussed the more rewarding for having struggled through the details preceding them.

Inevitably in a work of this size, where the emphasis is on theory, there will be numerous typographical errors, and there is no doubt that this is an occasional distraction, particularly where incorrect equation numbers are quoted. Despite this, this reviewer gained considerable pleasure, as well as knowledge, from his task, and the book will undoubtedly become one of the standard references in the field.

Chiang Mei has written a thoroughly enjoyable account of a wide selection of topics in the area of ocean surface wave dynamics. It is a measure of his breadth of research interests that, although the choice reflects much of his own work and that of his students, the overall contents form a balanced whole with so many important areas covered.

D. V. EVANS