J. Fluid Mech. (1973), *vol.* 57, *part* 3, *p.* 623
Printed in Great Britain

REVIEWS

The Method of Weighted Residuals and Variational Principles. By B. A. FINLAYSON. Academic Press, 1972. 412 pp. $22.50.

The author asserts that this book is for people who want to solve problems formulated as differential equations in science and engineering. While he has limited his subject area to fluid mechanics and heat and mass transfer, the ideas expounded have much wider applicability. Surely this excellent treatment will be employed by many, regardless of their specialized interests.

The eleven chapters are organized into two parts – Part I considers the *method of weighted residuals* and Part II treats *variational principles*. Each of these begins with a relatively simple motivational treatment followed by a wide variety of examples (both linear and nonlinear) taken from the literature and the author's own work. The exposition is primarily via these examples but the theory is by no means ignored. The last chapter (no. 11) discusses the problems and presents some of the available theorems concerning convergence and error bounds. References to this chapter are continually made throughout the text.

Throughout the entire volume the author includes suggestions on the choice of trial functions, compares and contrasts methods and suggests lines of research for practitioners of theory and applications. The style is concise. Obviously great effort has been expended in examining a widely scattered literature. Over 500 references supplement the text. Among the special topics one finds considerations of multiple solutions, existence of variational principles, applications of variational and reciprocal variational principles for determination of upper and lower bounds and error bounds using maximum principles, just to mention a few. The treatment of orthogonal collocation is especially interesting.

The format of the volume appeals to the eye and the excellent subject and author indices greatly enhance accessibility of this 'gold mine'. The text has been carefully proofed although slips inevitably occur. In a few places the English falters and sometimes the author chooses words which exceed his intended meaning. While portions of the text are certainly accessible to graduate students a substantial subset is probably beyond the reach of any except mature researchers.

There is no doubt that this volume is a welcome addition to the literature and belongs on the working bookshelf of every serious research worker in a variety of science and engineering fields. Its primary use will be as a reference work in both universities and industry.

W. F. AMES

J. Fluid Mech. (1973), *vol.* 57, *part* 3, *p.* 624
Printed in Great Britain

FILM REVIEW

Breaking Waves. By S. P. KJELDSEN and G. B. OLSEN. Technical University of Denmark. 16 mm, black and white, 20 min. 1000 Kr (purchase) or 100 Kr (rental). In English.

The theory of surface waves of small amplitude is by now highly developed. In contrast, the study of breaking waves is relatively untouched. Breaking waves play an important role in the maintenance of our shorelines and in the coastal transport of sand and sediment. The time may be overdue for fluid dynamicists to plunge metaphorically into this mixed laminar and turbulent regime.

The publication of the above film, prepared by two students at the Institute of Hydrodynamics and Hydraulic Engineering of the Technical University of Denmark, is thus particularly opportune and welcome. The film first defines and describes the three main types of breakers on sloping beaches, namely the "spilling breaker" (a relatively gentle affair, in which the wave crest is nearly symmetrical and foam spreads gradually down the forward face); the "plunging breaker", in which the crest is markedly unsymmetrical and the foam penetrates deeply into the forward face of the wave; and the "surging breaker", which occurs only on steep beaches.

After a careful statement of terminology the film describes how the three main breaker types are found to depend mainly on two parameters: the gradient of the beach and the steepness of the waves in deep water. Certain length scales (such as the local depth of water) are seen to be irrelevant, at least when the wavelength is sufficiently large.

The film also shows how the "breaker height index" is found to depend on both the beach slope and the deep-water wave steepness. Lastly a fourth type of breaker, namely the "collapsing breaker" is mentioned. This is an intriguing variant of the surging breaker, in which the fluid appears suddenly to lose its forward momentum, and to collapse.

While the whole film is expository in character, being based largely on the previous work of Galvin and others, it is nevertheless fascinating and may well stimulate fluid dynamicists to be more active in this neglected branch of their subject. The photography is excellent, good use being made of an improvised travelling carriage to maintain the camera opposite the waves, and of flash photographs to demonstrate the orbital motion of fluid particles. Those viewers interested in sound effects will note the economical use of percussion both for background and emphasis.

In one respect only is the film disappointing, namely that in spite of its title it makes no mention of breaking waves or white-caps in deep water. Acting over a much greater area, deep-water white-caps are the tell-tale clue for the widespread conversion of wave momentum into surface currents. But to do justice to this subject perhaps a separate film is needed.

M. S. LONGUET-HIGGINS