J. Fluid Mech. (1974), *vol.* 63, *part* 3, *p.* 623
Printed in Great Britain

REVIEW

Perturbation Methods. By A. H. NAYFEH. Wiley, 1973. 425 pp. £9 (hardback) or £3.75 (paperback).

This is the most comprehensive book I know about singular perturbations, with respect to the number of topics covered and applied examples discussed. It is not very physical since the examples generally begin with the governing equations and end with the expansions obtained for their asymptotic solution. It is not very mathematical since all expansions are obtained formally and only a few are known to be uniformly valid. Furthermore, the presentation is not uniformly careful. But the time-honoured method of learning singular perturbation techniques is through working problems and analysing the step-by-step procedure others have used to solve such problems successfully. Nayfeh's book will promote such an education. It will also be of interest for reference; in part owing to over six hundred items contained in its bibliography.

The topic of matched asymptotic expansions is treated via the Van Dyke matching principle, rather than through Cole's limit-process expansions. A more direct composite expansion method is also explained. (Such expansions consist of an outer expansion plus a boundary-layer correction in terms of a stretched variable.) Several variants of two-timing procedures are presented, and applied (mostly) to problems on infinite domains. Wide applicability is claimed for the 'generalized method'. Under the heading 'strained parameters', the author adequately covers the Poincaré–Lindsteadt procedure and some of its generalizations. Lighthill's technique is presented with the familiar cautions. The discussion of averaging methods includes techniques using canonical variables, Lie series and the Lagrangian. The final chapter obtains expansions for linear ordinary differential equations with singular points or turning points, and discusses expansion methods for the reduced wave equation with a random index of refraction.

One might well find that too many different methods and examples are presented. The chapter on averaging, for example, seems to need more focusing, i.e. an emphasis on fewer procedures would be preferable, especially for the beginner needing a tool to begin to attack his (thesis) problem. The discussion of linear ordinary differential equations, on the other hand, offers fewer elaborately detailed alternatives, and is quite easily comprehended.

No reader of this book can fail to realize that problems of singular perturbations arise in studying a tremendous variety of scientific disciplines, and that great progress towards obtaining techniques for asymptotically solving these problems has recently resulted from successive (and sometimes cooperative) efforts by engineers, mathematicians and other scientists. Professor Nayfeh deserves our thanks for his herculean effort in organizing and summing up these results.

R. E. O'MALLEY