REVIEWS

Field Computations in Engineering and Physics. By A. Thom and C. J. Apelt. London: Van Nostrand. 165 pp. 30*s*.

This book is primarily concerned with the numerical solution of Poisson's equation (including Laplace's equation as a special case) and the biharmonic equation. The procedure of obtaining such solutions falls into two distinct parts: first, the formulation of whatever finite-difference approximations to the differential equations it is intended that the solution-values shall satisfy; secondly, the determination of the solution-values which do satisfy those approximate relations. A considerable list of books and papers could be compiled on the use of relaxation methods to perform the same functions, and it is therefore of interest to discover in what respects the so-called 'method of squares' used by the authors differs from the methods of relaxation. It would seem that, whereas those who advocate relaxation have developed a fairly rigid system for the formulation of their finite-difference approximations but have taken great care to emphasize the advantages of flexibility in their techniques for solving the consequent relations, Thom and Apelt, on the other hand, have introduced flexibility into the choice of approximations but retained a rigid process of solving the resulting equations. Thus, in dealing with Laplace's equation, we find on page 30 six alternative finite-difference approximations quoted for use at a typical node of a square mesh. The choice of which formula is used is left to the operator, and the principles on which his choice is made at times appear to be somewhat *ad hoc*. The method of solving the chosen approximations is that of systematically scanning the nodes of a square mesh covering the area of integration: the function-value at each node in turn is corrected to ensure current satisfaction of the finite-difference equation associated with the node.

The method is basically slow and relies for its usefulness on speeding-up devices, a leading one of which is described as the technique of 'differences'. This technique consists of recording the increments applied at each node in the scanning process; the increments of successive scans are then evaluated by simple arithmetical operations on the last recorded previous increments. The method thus avoids keeping any record of the residual errors; this is singularly unfortunate because only the eventual evanescence of all residuals really confirms that a solution has been achieved. A check on the first solution presented in the book—a boundary-value solution of Laplace's equation involving but nine internal nodes—reveals five residuals which could be further liquidated, one of them as large as -47. The last significant figure quoted in the nodal solution-values are thus not correct. The error is presumably caused by an accumulation of rounding-off errors, and on a large problem these might well assume serious proportions.

The authors state their opinion that their methods are ideally suited to electronic digital computation. The present reviewer thinks that this opinion should be treated with the utmost reserve, believing that in the long run direct methods of solving the simultaneous equations involved will always turn out to be more profitable with an electronic computer than any iterative method.

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Aerofoil Sections. By F. W. RIEGELS. Translated from the German by D. G. RANDALL. London: Butterworths, 1961. 281 pp. £10.

This is a translation of *Aerodynamische Profile,* published in German in 1958. The translation is good, following the German text closely but not too literally. The book deals only with the properties of aerofoils in two-dimensional flow, although many of the results given have been derived from experiments on aerofoils of finite aspect ratio. The emphasis is on flow at low Mach numbers, but some results are also given for high subsonic and supersonic speeds.

The most useful part of the book consists of about 150 pages of tables and graphs giving shapes and aerodynamic properties of aerofoil sections. The main families of aerofoils that are included are the early Göttingen series, the NACA four-figure and five-figure series and the DVL extensions of these, and the later NACA 6-series. Some other miscellaneous aerofoils are also included, bringing the total up to about 500 different aerofoils. The aerodynamic properties that are given include theoretical and measured pressure distributions, C_L, C_D and C_m as functions of α, $C_{L\max}$, $C_{D\min}$, C_{m0}, $dC_L/d\alpha$, no-lift angle, design C_L and position of aerodynamic centre (not all these properties are given for all the aerofoils). Some results with high-lift flaps and at high subsonic and supersonic speeds are also included. Many of the results have been obtained from early wind-tunnel tests at rather low Reynolds numbers, but for some purposes this may be no disadvantage and may even enhance the usefulness of the book, since such aerofoil data are often difficult to find in other publications. The high turbulence of the stream in many of the early wind tunnels introduces a serious difficulty, and the values given for quantities such as C_D and $C_{L\max}$, which are known to be sensitive to turbulence, should be used with caution.

The tables and graphs of aerofoil data will be useful to anyone who is concerned with the application of aerofoils in any form. Unfortunately the reader may in some cases have difficulty in understanding the conditions under which particular experimental results were obtained. For example, there are a few cases in which the Reynolds number is not given, and there are some tables which apparently refer to tests in water with cavitation, although this is not stated.

The tables and graphs that have been described are preceded by about 100 pages of introductory text. This starts with a brief account of the main families of aerofoils, giving an explanation of the notation used in specifying the members of each family. In the next chapter there is a short description of some of the wind tunnels from which test results have been taken. This should certainly not be regarded as a survey of the World's wind tunnels; indeed most of the good modern tunnels are not mentioned, and many of the tunnels that are included are obsolete or have even been demolished. Nevertheless, the section will serve a useful purpose if read carefully in conjunction with the test data of the tables and graphs.

The discussion of wind-tunnel turbulence and its effects is based mainly on critical Reynolds numbers for spheres and is really obsolete. A reader who relied on this discussion for his knowledge of the subject might be seriously misled.

In the next chapter the author gives some concise general information about the properties of aerofoils, with typical values of quantities such as $C_{L\max}$, $dC_L/d\alpha$ and $C_{D\min}$. This is followed by a brief account of effects of roughness and cavitation, and a very short chapter on flaps.

The next chapter, on boundary-layer control, is so much out of date that its only interest is historical. The important developments made in this field in the last ten years have been almost completely ignored.

The remainder of the introductory text consists of two short chapters on aerofoil theory and two more on effects of viscosity and compressibility. In the former chapters there is an outline of thin-aerofoil theory, giving some of the more important results. The basis of Theodorsen's method is also described briefly, but the important later work of Goldstein, Lighthill and Thwaites is dismissed in a sentence.

The chapter on viscous effects gives a brief review of methods of calculating the flow in a boundary layer and the profile drag of an aerofoil. There is also a short discussion of boundary-layer stability and the problem of predicting transition. The section on maximum lift is poor; only turbulent separation is considered and there is no mention of 'short' and 'long' bubbles. The work of Preston on the effect of the boundary layer on lift is ignored.

In the short chapter on compressibility effects, there are satisfactory outlines of subsonic and supersonic linearised theory and of transonic similarity theory. The short section on transonic flow with shock waves is based mainly on work done during the war and is now out of date.

As already stated, the tables and graphs form the most useful part of the book. Because of the tendency to emphasize German work at the expense of that done in England or the U.S.A., the book is not ideal as a single source of data, but it will form a most useful complement to the well known *Theory of Wing Sections* by Abbott and von Doenhoff.

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