Babbage's writings. Unfortunately, these writings in their original editions are far from accessible, and the present volume, which contains reprints of selected chapters from Babbage's autobiography and from the collection of papers put together by his son and published after his death (Obituary, *Nature*, 5, 28; 1871), is very welcome. It includes most of the material relating to computing machines, and some enjoyable extracts on other subjects; these serve to round out the picture of the man and his many activities. Babbage is extraordinarily readable, and I heartily recommend this volume of extracts to those who have not so far made his acquaintance.

M. V. WILKES

MATHEMATICAL PROBABILITY

Integration, Measure and Probability

By Prof. H. R. Pitt. (University Mathematical Monographs.) Pp. viii+110. (Edinburgh and London: Oliver and Boyd, Ltd., 1963.) 25s.

OBSEVING the natural world, scientists contend with indeterminacy and experimental error; error occurs increasingly on passing from exact to less exact sciences. Sometimes experimental conditions cannot be varied, data are collected as events occur, and the possible error is greater. Such limitations created the need for statistics and statistical physics, based on mathematical probability.

Following Kolmogoroff, probability in Prof. Pitt's book is a non-negative completely additive set function (a measure) with greatest attained value one, with most statistical parameters defined by integration. Undoubtedly the most successful integral of the past fifty years is Lebesgue's. Through those years, expositions became increasingly elegant, and one of the neatest accounts of Lebesgue integration can be found here. Any competitive (non-Lebesgue) integration theory will have to acquire an elegance like this.

The integral $A(\theta)$ of a simple function θ relative to a measure is a simple sum. For any real function f the upper integral $L(f)$ of $|f|$ is the infimum of sums of $A(\theta_m)$, for all sequences of simple functions $\theta_m \geq 0$ that satisfy:

$$|f| \leq \sum_{m=1}^{\infty} \theta_m$$

Further, f is integrable, with integral $L(f^+) - L(f^-)$, where f^+ , f^- are the positive and negative parts of f , if there is a sequence $\{\theta_n\}$ of simple functions such that $L(f - \theta_n) \rightarrow 0$. The essentials of integration theory are covered before p. 45.

Section 13 explains clearly the ideas of a random variable and functions of it, together with Tchebysheff's inequality, distributions and characteristic functions, independence, mean, and variance. In further sections, Prof. Pitt defines point and (absolutely) continuous distributions in k -dimensional Euclidean space, the usual statistical parameters, conditional probabilities, Bayes's theorem, the correlation ratio, regression curves, and several distributions including the joint distribution of the mean and variance of a normal sample.

Ordinary statistical students will find most of their probability theory here. The β -distribution (incomplete β -function), Student's t (the ratio of a normal and a χ variable), and Snedecor's F and Fisher's z (from the ratio of two Γ -distributions) are missing. But as Prof. Pitt did not intend to discuss mathematical statistics, he had to draw the line somewhere.

The Central Limit problem is discussed following Kolmogoroff, Khintchine and Lévy. Borel's 0,1 principle, auto-correlation, the Wiener and Poisson processes, and suggestions for further reading, conclude the book.

A small point is that theorem 4, p. 8, is correct, though proved wrongly. For if $J_n = [-n^{-1}, 0)$ then $J_n = [-\delta, -\varepsilon]$ for $\delta > \varepsilon > 0$, and J_n is disjoint from J_m if $m^{-1} < \varepsilon$. However, though needed for Lebesgue integration, complete additivity is not necessary for Lebesgue-type theorems to hold (see Henstock, *Theory of Integration* (Butterworths, 1963), where special cases of a new theory are given). Thus we can remove Kolmogoroff's restriction of complete additivity. This remark does not detract from Prof. Pitt's book, since it was written before mine appeared.

Prof. Pitt and Oliver and Boyd are to be congratulated on an excellent beginning of a new series of monographs.

R. HENSTOCK

MODERN TRENDS IN SEISMOLOGY

An Introduction to the Theory of Seismology

By Prof. K. E. Bullen. Third edition. Pp. viii+381. (Cambridge: At the University Press, 1963.) 57s. 6d. net.

THE years following the publication of Bullen's *Introduction to the Theory of Seismology* in 1947 have seen a very considerable growth in earthquake science; new branches of the subject have been developed, the relationships with geology and physics have become closer, and the need for an up-to-date edition has been pressing.

Now an extensive revision of a treatise in these circumstances becomes a matter of nice discrimination. Where the value of the earlier edition had been abundantly proved there was little need to change the fundamental plan of exposition; but a writer with less discrimination and self-discipline could easily have spoiled the unity of the work by overloading it with the details of a large number of modern researches. Prof. Bullen's book in both its first edition and in the revised second edition has been remarkable for the economical way in which an enormous body of theory and relevant fact has been set out at modest length in an entirely readable form. The third edition retains all these characteristics while incorporating much of the modern development. These additions are all the more vivid inasmuch as some of them involve Bullen's own recent researches.

The steady growth in the popularity of Bullen's *Introduction to the Theory of Seismology* indicates how valuable it is proving to students and working seismologists alike. A comparison of the second and third edition indicates how, even apart from essentially new topics, the science has advanced. For example, there is now more to be said about the distribution of density within the Earth, and much of the argument rests on Bullen's own researches; the importance of geochemical arguments is increasingly apparent. The regions A to G into which Bullen more than twenty years ago divided the interior of the Earth have now come into fairly general use; it would indeed have helped the reader if these regions had been indicated in the various diagrams that show the variation of velocity, density and elasticity within the Earth.

The subject of the long-period oscillations of the Earth, largely dormant since Love's researches in 1911, has received considerable attention during the past twenty years, and a suggestion of Benioff that the strain seismograph at Pasadena had recorded a free oscillation of 57-min period resulting from the Kamchatka earthquake of 1952 November 4 gave a new impetus both to the theoretical calculation of free periods and to the search for more definite evidence of their existence. Extensive computations of these periods were made by Pekeris and others: the verification, the result of analyses of the records of the Chile earthquake of 1960 May 22 both on seismographs and on a tidal gravity meter, was announced during the Helsinki meeting of the International Associa-