## Clenshaw-Curtis formula

Table 4
Values of $\left|a_{N}\right|,\left|a_{N-2}\right|,\left|a_{N-4}\right|$ defined by equation (3), and $\left|I_{N}-I_{N / 2}\right|$ defined by equation (4)

|  | $N$ | $\left\|a_{N}\right\|$ | $\left\|a_{N-2}\right\|$ | $\left\|a_{N-4}\right\|$ | $\left\|I_{N}-I_{N / 2}\right\|$ |
| :--- | ---: | :--- | :--- | :--- | :--- |
|  | 8 | $0.645(-5)$ | $0.859(-4)$ | $0.940(-3)$ | $0.589(-4)$ |
| $\int_{0}^{1} \frac{d x}{1+x^{2}}$ | 16 | $0.235(-10)$ | $0.425(-9)$ | $0.655(-8)$ | $0.828(-9)$ |
|  |  |  |  |  |  |
|  | 8 | $0.156(-1)$ | $0.963(-2)$ | $0.265(-1)$ | $0.997(-2)$ |
| $\int_{0}^{1} \frac{d x}{1+100 x^{2}}$ | 16 | $0.440(-3)$ | $0.409(-3)$ | $0.242(-3)$ | $0.310(-3)$ |
|  | 32 | $0.222(-6)$ | $0.373(-6)$ | $0.491(-6)$ | $0.142(-6)$ |
|  |  |  |  |  |  |
|  | 8 | $0.252(1)$ | $0.262(1)$ | $0.294(1)$ | $0.960(0)$ |
| $\int_{0}^{1} \frac{d x}{1-0.98 x^{4}}$ | 16 | $0.732(0)$ | $0.761(0)$ | $0.853(0)$ | $0.954(-1)$ |
|  | 32 | $0.744(-1)$ | $0.774(-1)$ | $0.868(-1)$ | $0.318(-2)$ |

## Book Review

Modern Factor Analysis, by Henry H. Harman, Second edition, revised, 1967; 474 pages. (Chicago and London: The University of Chicago Press, $\$ 12.50$ (104s.).)
Factor analysis has been applied in many fields and, it seems, to research problems of all kinds. Among the applications listed in this book, for instance, is the investigation by Sackman and Munson, reported in the ACM Journal in 1964 into computer operating time and system capacity for manmachine digital systems. The application of statistical techniques and mathematical models to such problems is gratifying and this kind of applicability may be regarded as a recommendation in itself for the factor approach. It should be pointed out, however, that factor analysis has been generally considered to be a method employing geometrical concepts born out of the necessity to interpret multi-dimensional relationships between variables. This analysis exploits the variations and correlations of the variables, and the rather difficult statistical theory underlying some techniques has not yet been completely worked out. A consequence of this is that significance testing is not always available in applications. In any case, the process of identification of factors has inherent non-uniqueness which causes difficulties of interpretation. Nevertheless, factor analysis with its variety of techniques will continue to provide a valuable means of interpreting data for an increasing number of applied problems.
This book is the second edition of an important text which first appeared eight years ago dealing with the methodology of factor analysis. There has been a considerable revision of the structure and content of many chapters in order to reflect the changed emphasis between the various factor tech-
niques. Principally these changes concern the shift from hand-machine to computer techniques; many flow diagrams and detailed references to computer software are given in the book. Another improvement is the more general use of matrix notation which makes the presentation more consistent.

The first four parts of the book embrace the foundations of factor analysis, direct solutions, derived solutions and factor measurements. A final part of the book consists of problems and solutions. Used as a textbook a student may well find it inconvenient to have not only answers at the end of the book but problems also. An elementary introduction to matrices and Cartesian geometry is included in two chapters of the first part. The numerical processes of factor analysis, the solution of linear equations, matrix inversion, determination of eigenvalues and rotation of axes are discussed in turn in separate parts of the book, and detailed descriptions of hand-machine processes are given. References to more efficient developments in computer methods developed in the past decade are mentioned briefly but not discussed.

This book will clearly continue to serve as a valuable text for research workers who are concerned with the interpretation of multivariate data whose needs are not fulfilled by the more widely used and understood techniques like multiple regression analysis. It still provides the best introduction to the terminology, concepts and methodology of factor analysis. The presentation throughout is of a high standard and the author has taken pains to strengthen the content of this second edition, not least the bibliography in which almost one third of the 550 listed works have appeared since the publication of the first edition.
R. W. Hiorns (Oxford)

