saving a great deal of programmer's time. The latter allows for the full 9 significant decimal figure accuracy and can accommodate numbers in the range $10^{\pm 8000}$.

The encouraging start made at Rothamsted seems to indicate that electronic computers are well suited for dealing with statistical problems, but undoubtedly new numerical and programming techniques are necessary to meet the special requirements of such work.

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REVIEWS AND DESCRIPTIONS OF TABLES AND BOOKS

This section contains reviews and descriptions of tables and of publications which in some explicit way have general interest in connection with tables or computation. Those noted as "Deposited in the UMT File" have been deposited in the Unpublished Mathematical Tables file maintained by the Chairman of the Editorial Committee; they are available there for reference. In many cases the author of these tables has a limited number of copies available for distribution. Authors of works containing mathematical tables of general interest or which otherwise fall into the classes noted or reviewed here are urged to submit a copy to the Chairman of the Editorial Committee.

31[A, F].—RSMTC *Table of Binomial Coefficients.* Royal Soc. Math. Tables, v. 3. Edited by J. C. P. MILLER. Cambridge 1954. viii + 162 p. 21.5 × 28.0 cm. Price $6.50.

This table gives exact values of binomial coefficients

$$\binom{n}{k} = \frac{n!}{k!(n-k)!}$$

for positive integer values of k and n. The main table (p. 2–103) is for $n \leq 200$. Because

$$\binom{n}{k} = \binom{n}{n-k}$$

it is unnecessary to print values for $k > n/2$. Actually k is taken less than or equal to $(n + 1)/2$ plus whatever additional values of k fill out the line. The central binomial coefficient in case n is even, or the two central coefficients in case n is odd, are printed in bold face type.

The rest of the table is for $n \leq 5000$ but for $k \leq L$ limited as follows

n	L
200–500	12
500–1000	11
1000–2000	5
2000–5000	3

Thus the table contains in particular the first 5000 triangular and tetrahedral numbers.

The arrangement of the table is such that the coefficients $\binom{n}{k}$ and $\binom{n}{k+1}$ are in general adjacent entries in the same line; that is, column headings are k. The opposite arrangement in which $\binom{n}{k}$ $(k = 0, 1, 2, \cdots)$ form a column of data would be perhaps more convenient for most purposes but would, no doubt, have rendered a difficult printing problem more difficult. On page 1 there is an index by means of which the reader can find any particular binomial coefficient.

The printing is by Cambridge University Press and is superlative, as always.

This table is intended primarily for number theorists whose interests in binomial coefficients are such that exact values are required. For the more practical man who wants no more than a half dozen significant digits the table will no doubt prove irritating in spite of the fact that the printer has supplied auxiliary figures to help him truncate the exact values and to express them in floating decimal notation. However the practical man may also have his curiosity aroused by inspection of the table. He may observe for example that for a fixed n the number of odd binomial coefficients is always a power of 2. For such reasons the reviewer would recommend the table for general use. These are the most extensive tables of this function yet published. They are the result of many collaborating calculators.

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32[B].—Admiralty Research Laboratory, "Tables of $\eta = \sqrt{\{m^2 + \sqrt{-1}\}}$," A.R.L./T.7/Maths 2.7, April 1954, 4 p., Teddington, Middlesex, England.

The tabulation to six decimal places with second differences of $|\eta|$, arg η, $R(\eta)$ and $I(\eta)$ is given for $m = 0(.02)3(.1)$ up to the point where $\eta = m + \frac{1}{4}m^{-3}$, $\arg \eta = \frac{1}{2}m^{-2}$, $R(\eta) = m + \frac{1}{8}m^{-3}$, $I(\eta) = \frac{1}{2}m^{-1}$, to the accuracy of the table.

I. A. Stegun

NBSCL

33[D].—NBS *Tables of Circular and Hyperbolic Sines and Cosines for Radian Arguments*. Appl. Math. Ser. No. 36. U. S. Gov. Printing Office, Washington, 1953. x + 407 p. Price $3.00.

This is the third edition, published in 1953, of this set of tables originally published in 1939. See **RMT 89[D, E]**, *MTAC*, v. 1, 1943–45, p. 45, and Note 114, v. 4, 1950, p. 123. The present edition corrects two inconsistencies of format and six printing errors of the first edition; five of these printing errors have been corrected in the second edition.

The only other reported change is an extension of a supplementary table, which now expresses degrees, minutes, and seconds, in terms of radians to 10 decimal places and selected values of radians in terms of degrees, minutes, and seconds, to an accuracy of 0.000005 second.

C. B. T.

34[D].—L. W. POLLAK, *Eight-Place Supplement to Harmonic Analysis and Synthesis Schedules for Three to One Hundred Equidistant Values of Empiric Functions*. Second Edition, Dublin Institute for Advanced Studies, School of Cosmic Physics, Geophysical Memoirs No. 1, Dublin, 1954. Price £1 2s. 6d.

This is a second edition to the work issued in 1949, **RMT 847[K]** reviewed in *MTAC*, v. 5, 1951, p. 19–21. The work was written to be associated with "All term guide for harmonic analysis and synthesis," see **RMT 899[K]**, *MTAC*, v. 5, 1951, p. 149. However, directions are included for its use independently of the earlier "Guide."

In the present issue the accuracy of angles given in degrees, minutes, seconds, and fractions of a second, columns headed iz and $\lambda z'$ has been carried to ten decimal places of a second. Some checks of accuracy of the earlier work are reported, and it is reported no mistakes were discovered.

C. B. T.

35[E].—AECD-3497, S. FRANKEL and E. NELSON, "Methods of treatment of displacement integral equations," Sept. 1953. Available from Office of Technical Services, Department of Commerce, Washington 25, D. C.

This contains on p. 78–82, a table of $k = k(f)$ defined by

$$-1 \leq f \leq 0, \quad \frac{1}{1+f} = \frac{\operatorname{arctanh} k}{k}$$

$$0 \leq f \leq \infty, \quad \frac{1}{1+f} = \frac{\arctan k}{k}$$

$f = -1(.01)2(.1)5(.5)10$. The table is to 6D, with first differences given.

A polynomial of degree 5 in $(1 + f)^{-1}$ which gives 4D in the range $8 < f < \infty$, is given.

J. T.

36[K].—LESLIE E. SIMON and FRANK E. GRUBBS, *Tables of the Cumulative Binomial Probabilities*. Ballistic Research Laboratories, Ordnance Corps. Pamphlet ORDP20-1, Aberdeen Proving Ground, 1952. 577 p. + viii, 12 × 9 inches, photo-offset from typescript. Available at U. S. Gov. Printing Office, Washington, D. C.

This table lists

$$P(c, n, p) = \sum_{r=c}^{n} \binom{n}{r} p^r (1 - p)^{n-r}$$

for $c = 1(1) \cdots$ to $P < 10^{-7}$, $n = 1(1)150$, and $p = .01(.01)50.00$. This carries n much farther than other available tables.

The introduction and foreword explain the use of the tables and give three illustrative examples. It is pointed out that the Incomplete Beta function $I_p(c, n - c + 1) = P(c, n, p)$ can be read from the table.

The type is small but is generously spaced: each value of n has an integral number of pages for its own.

H. Campaigne

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37[L].—L. Fox, *A Short Table for Bessel Functions of Integer Order and Large Arguments.* Cambridge, 1954. Royal Society Shorter Mathematical Tables, No. 3. 28 p. Price $1.25. 27.8 × 21.7 cm.

The present tables are intended to supplement the tables of Bessel functions of integral order, J_n, Y_n, I_n and K_n previously prepared by the British Association Mathematical Tables Committee. In the earlier volumes the functions were tabulated for n varying from 0 to 20 and x in the range from 0 to 20 or 25. Here the range of x extends from 20 to ∞. However, the tabular argument is $1/x$ so that use of the tables requires calculation of a reciprocal before entering. This device permits coverage of the range by means of fifty tabular values, namely $1/x = z = 0(.001).05$. In the case of $J_n(x)$, $Y_n(x)$ the usual auxiliary functions $P_n(x)$, $Q_n(x)$, for which

$$J_n(x) \sim \sqrt{\frac{2}{\pi x}}\,[P_n(x)\cos(x - \tfrac{1}{2}n\pi - 1/4\pi) - Q_n(x)\sin(x - \tfrac{1}{2}n\pi - \tfrac{1}{4}\pi)],$$

$$Y_n(x) \sim \sqrt{\frac{2}{\pi x}}\,[P_n(x)\sin(x - \tfrac{1}{2}n\pi - 1/4\pi) + Q_n(x)\cos(x - \tfrac{1}{2}n\pi - \tfrac{1}{4}\pi)],$$

are tabulated. In the case of $I_n(x)$, $K_n(x)$, the auxiliary functions $F_n(x)$, $Y_n(x)$ such that

$$I_n(x) \sim \frac{e^x}{\sqrt{2\pi x}}\,F_n(x), \quad K_n(x) \sim \sqrt{\frac{\pi}{2x}}\,e^{-x}G_n(x)$$

are tabulated. P_n and Q_n are given to nine decimals for $n = 0(1)9$ and to eight for $n \geq 10$. F_n and G_n are given to nine decimals for $n = 0(1)9$ while $\ln F_n$ and $\ln G_n$ are given to eight decimals for $n \geq 10$. Modified second and fourth central differences are given for interpolation.

P_n and Q_n were computed for $n = 0$ and $n = 1$ for $z = 0(.005).07$ and the recurrence relations

$$P_{n+1} - P_{n-1} = -2nzQ_n$$

$$Q_{n+1} - Q_{n-1} = 2nzP_n$$

were used to generate the values for those arguments for $n = 2(1)10$. The values were then subtabulated at intervals of .001 for $n = 0(1)10$. For $n > 9$ subtabulation was not always convenient and the values at intervals of .001 were generated by recurrence. Similar methods were used for the computation of F_n and G_n. The tables were reproduced by photo-offset from a manuscript prepared on a card-operated typewriter. From the numerous checks applied in the course of preparation one may feel confident that these tables are free from error.

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British Association Mathematical Tables, vol. 6. *Bessel Functions, Part I: Functions of orders zero and unity.* Cambridge University Press, 1937, reprinted 1950. [See **RMT 179[L]**, *MTAC*, v. 1, 1944, p. 361.]

British Association Mathematical Tables, vol. 10. *Bessel Functions, Part II: Functions of positive integer order.* Cambridge University Press, 1952. [See **RMT 1087[L]**, *MTAC*, v. 7, 1953, p. 97.]

38[L].—NBSCL, *Table of the Gamma Function for Complex Arguments.* NBS Applied Mathematics Series No. 34. U. S. Gov. Printing Office, Washington, D. C., 1954, xvi + 105 p., 22 × 20 cm. Price $2.00.

Values of the gamma function for complex arguments are required for work in atomic and nuclear physics, engineering, and elsewhere, and the publication of a reliable basic table of this function is to be welcomed. The present volume gives 12D values of the real and imaginary parts of $\log_e \Gamma(x + iy)$ for $x = 0(.1)10$, $y = 0(.1)10$. The values for negative y may be obtained simply by changing the sign of the imaginary part, the values for negative x from the relation $\Gamma(z)\Gamma(1 - z) = \pi \operatorname{cosec} \pi z$. To facilitate computation from this last formula, auxiliary tables of $\sin \pi x$, $\cos \pi x$, $\sinh \pi x$, $\cosh \pi x$ to 15D or 15S for $x = 0(.1)10$ are included. Thus, the tables given in this volume may be said to cover the region $-9 \leq x \leq 10$, $-10 \leq y \leq 10$. The effective range of the tables may be doubled in each direction by an application of the duplication formula; and outside the so increased range, the asymptotic expansion of $\log \Gamma(z)$ may be used.

Key values of $\log_e \Gamma(x + iy)$ for $x = 9(.1)10$, $y = 0(.1)10$ were computed to 15D from Stirling's expansion, the values for $0 \leq x \leq 8.9$ were obtained from the key values by application of the recurrence relation $\Gamma(z) = z^{-1}\Gamma(z + 1)$. A detailed description of the computation is given in the Introduction by H. E. SALZER which contains also notes on the purpose and scope of the table, on some properties of the gamma function, and on direct and inverse interpolation in the table. Also included is a bibliography listing 11 other tables of gamma functions for complex arguments, 16 auxiliary tables, and 16 references to books and papers containing relevant material on the gamma function.

The technical staff of the Mathematical Tables Project at the start of this undertaking consisted of A. N. LOWAN, Chief, MILTON ABRAMOWITZ, GERTRUDE BLANCH, ABRAHAM HILLMAN, WILLIAM HORENSTEIN, MEYER KARLIN, JACK LADERMAN, IDA RHODES, H. E. SALZER, and IRENE STEGUN. The key values for $9 \leq x \leq 10$ were computed by hand on desk calculators by RUTH CAPUANO, LEONA FREEMAN, ABRAHAM GROSSMAN, and RUTH ZUCKER. The extension to $0 \leq x \leq 8.9$ was done largely on punch-card machinery, by MILTON STEIN, who was also responsible for preparing and checking the final manuscript.

A. E.

39[L].—AKADEMIÎÂ NAUK SSSR. [Institute of Exact Mechanics and Computational Techniques.] *Tablîŝy Integralnogo sinusa i kosinusa* [*Tables of the sine and cosine integral*]. Moscow, 1954. 473 p. 25.7 × 19.7 cm. 43.75 rubles.

These tables give, to 7D,

$$Si(x) = \int_0^x t^{-1} \sin t dt$$

$$Ci(x) = \int_\infty^x t^{-1} \cos t dt$$

for $x = 0(.0001)2(.001)10(.005)100$.

There is a one page table of $C_i(x) - \ln x$ for $x = 0(.0001).0099$. These are rounded values taken from the 1940, 1942 NYMTP tables of these functions,[1] except that the range $10 < x < 100$, with the old interval of .01, has been subtabulated to .005. This was apparently done by hand, punched on cards, and checked with a tabulator. In most places no differences are given since linear interpolation suffices. When they are not negligible, second differences are given. A one page table of $\frac{1}{2}t(1 - t)$ and a nomogram for interpolating with Δ^2 are supplied as inserts. The table is well printed on good quality paper. With good proof reading this could be a very accurate table. If one does not need the exponential integral, or more than 7D accuracy, this volume is a handy replacement for the three NYMTP volumes.

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[1] NYMTP. *Tables of Sine, Cosine and Exponential Integrals.* V. 1, 2. New York, 1940. *Table of Sine and Cosine Integrals*. New York, 1942.

40[L].—AKADEMIÎA NAUK SSSR. [Institute of Exact Mechanics and Computational Techniques.] *Tablitsy Integralov Frenelya* [*Tables of Fresnel Integrals*]. Moscow, 1953. 271 p. 16.2 × 25.8 cm. 23.50 rubles.

These fundamentally new tables of the Fresnel integrals

$$S(x) = \int_0^x \sin \tfrac{1}{2}\pi t^2 dt = \frac{1}{2}\int_0^x J_{\frac{1}{2}}(t)dt$$

$$C(x) = \int_0^x \cos \tfrac{1}{2}\pi t^2 dt = \frac{1}{2}\int_0^x J_{-\frac{1}{2}}(t)dt$$

give 7D values of these functions for

$$x = 0(.001)25$$

together with average second differences

$$\tfrac{1}{2}\{\Delta^2 f(x - \Delta x) + \Delta^2 f(x)\}.$$

Two short tables near $x = 0$ give 7S values (rather than the 7D values of the main table). These are tables of

$$S(x) \quad \text{for} \quad x = 0(.001).58$$

and

$$C(x) \quad \text{for} \quad x = 0(.001).101.$$

For interpolation there are two tables of $t(1 - t)/2$ for $t = 0(.001).5$ and a nomogram for finding $\frac{1}{2}t(1 - t)\Delta^2$.

The table was found by successive quadrature performed by Simpson's rule between the points $x = n$ and $x = n + 1$, $n = 0(1)24$. These 26 key values were computed from the power series and asymptotic formulas for S and C.

The most extensive previous tables of the Fresnel integrals are those of van WIJNGAARDEN & SCHEEN [*MTAC*, v. 4, p. 155] which appeared in 1949. These tables are to 5D for $x = 0(.01)20$.

The tables are well printed on good quality paper and represent a very considerable number of man hours of effort.

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41[L].—ADMIRALTY RESEARCH LABORATORY, "Table of $|I| = \left|\int_0^{\varphi} \sec\theta e^{i\mu\sec\theta} d\theta\right|$", A.R.L./T8/Maths 2.7, April 1954, 13 p., Teddington, Middlesex, England.

The function $|I|$ is tabulated to four decimal places for $\mu = 1(1)13$. The intervals in the table have been so chosen that linear interpolation in the φ direction for the most part is adequate, or at most, the tabulated second differences must be used. In the region around $\varphi = 90°$, the auxiliary functions $h(\mu)$, r and λ are given, where $|I| = h(\mu)\{1 + 2r\cos\Omega + r^2\}^{\frac{1}{2}}$ and Ω (in degrees) $= \lambda + \frac{180}{\pi}\mu\sec\varphi$.

I. A. STEGUN

NBSCL

42[L].—H. GELLMAN and JEAN TUCKER, "Tables of the functions $D_0(x)$ and $D_1(x)$." Atomic Energy of Canada Limited, Chalk River, Ontario, 1954. 51 p., 21.5 × 27.5 cm. $1.50.

The functions tabulated in this report are

$$D_0(x) = \frac{1}{\pi}\int_{-\pi/2}^{\pi/2} d\theta \exp(-x\cos\theta)$$

and $D_1(x) = -D_0'(x)$. They can be expressed in terms of modified Bessel functions and modified Struve functions as

$$D_0(x) = I_0(x) - \mathbf{L}_0(x), \quad D_1(x) = \frac{2}{\pi} - I_1(x) + \mathbf{L}_1(x).$$

$D_0(x)$ and $D_1(x)$ have been calculated on FERUT, the Ferranti Universal Digital Computor at the University of Toronto, and 7D values of them are given here for $x = 0(.001)4.999$.

A. E.

43[L].—M. ROTHMAN, "Tables of the integrals and differential coefficients of Gi$(+x)$ and Hi$(-x)$." *Quart. Jn. Mech. Appl. Math.*, v. 7, 1954. p. 379–384.

The functions

$$\mathrm{Gi}(x) = \pi^{-1}\int_0^\infty \sin\left(ux + \frac{u^3}{3}\right)du, \quad \mathrm{Hi}(-x) = \pi^{-1}\int_0^\infty \exp\left(-ux - \frac{u^3}{3}\right)du$$

were introduced by SCORER.[1] The present paper contains 7D tables of

$$\int_0^x \mathrm{Gi}(t)dt, \quad \frac{d\mathrm{Gi}(x)}{dx}, \quad \int_0^x \mathrm{Hi}(-t)dt, \quad \frac{d\mathrm{Hi}(-x)}{dx}$$

for $x = 0(.1)10$, with $\gamma_m{}^2$. The tables were obtained by numerical integration and differentiation of 10D tables of Gi(x) and Hi$(-x)$, and the results were compared with those obtained from the asymptotic expansions for large x. The author has computed values up to $x = 20$, which are available if required.

A. E.

[1] R. S. SCORER, "Numerical evaluation of integrals of the form $I = \int_{x1}^{x2} f(x)e^{i\phi(x)}dx$ and the tabulation of the function $\mathrm{Gi}(z) = \frac{1}{\pi}\int_0^\infty \sin\,(uz + \frac{1}{3}u^3)du$," *Quart. Jn. Mech. Appl. Math.*, v. 3, 1950, p. 107–112; *MTAC*, v. 4, 1950, p. 215.

44[L].—M. ROTHMAN, *Table of the integrals of* Ai$(\pm x)$ *for* $x = 0.00(0.01)2.00$ *and* $x = 0.0(0.1)10.0$. i + 6 p. mimeographed. Deposited in the UMT FILE.

Ai(x) is the Airy integral of the first kind, and the tables give

$$\int_0^x \mathrm{Ai}(t)dt$$

to 8D with $\delta_m{}^2$. The integrals were computed at intervals of 0.1 using the method of reduced derivatives. J. C. P. MILLER's unpublished table of reduced derivatives of Ai(x) was used. A shortened version of this table has been published (see **RMT 1231**, *MTAC*, v. 8, 1954, p. 162).

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45[L].—M. ROTHMAN, *Table of* Bi$(+x)$ *for* $x = 0.00(0.01)2.00$ *and* Bi$(-x)$ *for* $x = 0.00(0.01)10.00$. i + 6 p. mimeographed. Deposited in the UMT FILE.

Bi(x) is the Airy integral of the second kind, and the tables give 8D values of Bi$(\pm x)$ with $\delta_m{}^2$. The computation was carried out using the method of reduced derivatives and 12D were carried throughout the calculations. J. C. P. MILLER's manuscript tables of Bi(x) and its reduced derivatives were utilized.

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46[L].—M. ROTHMAN, *Table of the integrals of* Bi$(\pm x)$ *for* $x = 0.00(0.01)2.00$ *and of* Bi$(-x)$ *for* $x = 0.0(0.1)10.0$. i + 6 p. mimeographed. Deposited in the UMT FILE.

8D tables, with δ_m^2, of

$$\int_0^x \mathrm{Bi}(t)dt,$$

Bi(x) being the Airy integral of the second kind. The integrals were computed at intervals of 0.1 using the method of reduced derivatives. J. C. P. MILLER's manuscript tables of reduced derivatives of Bi(x) were used. The integrals were also computed from their ascending power series for $|x| \leq 2$.

A shortened version of this table has been published (**RMT 1231**, *MTAC*, v. 8, 1954, p. 162).

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47[L].—M. ROTHMAN, *Table of* Gi(x) *and its derivative for* $x = 0.0(0.1)25(1)75$. i + 6 p. mimeographed. Deposited in the UMT FILE.

A shortened version of the table of Gi$'(x)$ has been published (see review 41 above). The mimeographed pages give 8D values of Gi(x) and Gi$'(x)$ with δ_m^2 (and for $x < 2.5$ also γ^4). The table of Gi$'(x)$ was obtained by numerical differentiation of a 10D table of Gi(x).

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48[L].—M. ROTHMAN, *Table of* Hi$(-x)$ *and its derivative for* $x = 0.0(0.1)25(1)75$. i + 6 p. mimeographed. Deposited in the UMT FILE.

A shortened version of the table for Hi$'(-x)$ has been published (see review 41 above). The mimeographed pages give 8D values of Hi$(-x)$ and Hi$'(-x)$ with δ_m^2 (and for $x < 2$ also γ^4). The table of Hi$'(-x)$ was obtained by numerical differentiation of a 10D table of Hi$(-x)$.

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49[L].—M. ROTHMAN, *Tables of the integrals of* Gi(x) *and* Hi$(-x)$ *for* $x = 0.0(0.1)$-20.0. 4 p. mimeographed. Deposited in the UMT FILE.

A shortened version of these tables has been published (see review 41 above). The mimeographed pages give 8D values, with δ_m^2 (and in a few places also γ^4), of

$$\int_0^x \mathrm{Gi}(t)dt, \quad \int_0^x \mathrm{Hi}(-t)dt.$$

The integrals were obtained by numerical integration of 10D tables of $\mathrm{Gi}(x)$ and $\mathrm{Hi}(x)$. They were checked from $x = 8$ onwards by comparison with results calculated from the asymptotic expansions.

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50[M].—TERENCE BUTLER and KARL POHLHAUSEN, *Tables of definite integrals involving Bessel functions of the first kind.* WADC Technical Report 54-420, Wright Air Development Center, 1954. 50 p. 21.5 × 27.5 cm.

γ_r is the rth positive zero of $J_0(z)$. All values are tabulated to 5D.

Table I. γ_r and $J_1(\gamma_r)$, $r = 1(1)10$. This table is taken from H. T. DAVIS and W. J. KIRKHAM, *Bull.* Amer. Math. Soc., v. 33, 1927, p. 760.

Table II. $J_\nu(\gamma_r)$, $r = 1(1)10$, $\nu = 1(1)\nu_r$, where ν_r is the last ν for which $J_\nu(\gamma_r)$ is not zero to 5D.

Tables III–VII.

$$\int_0^1 x^p J_0{}^m(\gamma_r x) J_1{}^n(\gamma_r x) dx,$$

where $p = 0(1)10$ and $r = 1(1)10$ in all tables; $m = 1$, $n = 0$ in Table III; $m = 0$, $n = 1$ in Table IV; $m = 2$, $n = 0$ in Table V; $m = 0$, $n = 2$ in Table VI; $m = n = 1$ in Table VII.

Tables VIII–X.

$$\int_0^1 x^p J_m(\gamma_r x) J_n(\gamma_s x) dx,$$

where $p = 0(1)5$, $r = 1(1)5$, $s = 1(1)5$ in all tables; $m = n = 0$ in Table VIII; $m = 0$, $n = 1$ in Table IX; and $m = n = 1$ in Table X.

A. E.

51[T, L].—ASCHER OPLER and NEVIN K. HIESTER, *Tables for Predicting the Performance of Fixed Bed Ion Exchange and Similar Mass Transfer Processes.* Stanford Research Institute, Stanford, California, 1954. Multilithed 111 p., $8\frac{1}{2} \times 11$ inches. Free.

A variety of problems in the theory of non-equilibrium operation of ion-exchange and absorption columns in the theory of heat transfer and in the theory of probability may be described by the partial differential equation

$$-\left(\frac{\partial\lambda}{\partial s}\right)_t = \left(\frac{\partial\omega}{\partial t}\right)_s = \lambda(1 - \omega) - r\omega(1 - \lambda).$$

The solution of these equations may be written as

$$\lambda = \frac{J(rs, t)}{J(rs, t) + e^{(r-1)(t-s)}[1 - J(s, rt)]}$$

$$\omega = \frac{1 - J(t, rs)}{J(rs, t) + e^{(r-1)(t-s)}1 - J(s, rt)}$$

where

$$J(x, y) = 1 - \int_0^x e^{-y-\xi} I_0(2\sqrt{y\xi}) d\xi.$$

The function $1 - J(x, y)$ has been previously calculated by BRINKLEY, EDWARDS, and SMITH (*MTAC*, v. 6, 1952, p. 40). However these calculations were found to be insufficient for the purposes of the authors when J was near zero or one.

The evaluation of λ and ω was carried out with an IBM 602-A using a modification on Onsager's asymptotic expansion.

Values are given to 4D and appear in three tables covering the following ranges.

Table I:	$r = 0.2(0.2)1, 2$	$s = 1, 2(2)8$	$t/s = 0.2, 0.5, 1, 2, 5$
Table II:	$r = 0.2(0.1)1, 1.2, 1.3, 1.4, 1.5, 2(1)5$		
	$s = 10(5)100(10)1{,}000$		$t/s = 0.1(0.1)0.4(0.2)1(1)4, 6$
Table III:	$r = 0.2(.1).9$	$s = 10(5)100(10)500$	t/s chosen so that $\lambda = 0.1$ and 0.9

The report contains the derivation of the differential equations in various problems and a description of the method of computation as well as the tables for λ and ω. In spite of a few typographical errors (e.g., Z occurring in equation (9), p. 13 should be read as 2), this report is a useful collection of material for workers concerned with mass transfer problems.

A. H. T.

52[V].—AERONAUTICAL RESEARCH COUNCIL, *A Selection of Graphs for Use in Calculations of Compressible Airflow.* Prepared by the Compressible Flow Tables Panel (L. ROSENHEAD, Chairman, W. G. BICKLEY, C. W. JONES, L. F. NICHOLSON, H. H. PEARCEY, C. K. THORNHILL, R. C. TOMLINSON) of the ARC. Oxford, 1954. x + 115 p., $11\frac{1}{2}'' \times 15\frac{1}{4}''$, 84 s. net.

This book is a companion volume to "Compressible Flow: Tables" (Clarendon Press, 1952), **RMT 1093[V]**, v. 7, 1953, p. 103. The preface states, "The object of both books is, briefly, to make available to engineers, physicists, and applied mathematicians a selection of tables and graphs likely to be of value in research and in calculations of the flow of air in which compressibility effects are important. It is hoped that the books will be useful both as an aid to design and for the development of new theory."

This handsomely printed and well thought-out book should succeed in fulfilling the hopes of the editors.

There are two types of graphs in this book, corresponding to single and double entry tables, and for both types single-page and multiple-page graphs are given. The single-page graphs are intended to give a quick appreciation of the variation of the quantities and they can also be used for rough working. The multiple page graphs corresponding to single entry tables enable one to take readings which approach those of the tables and in some cases are much more convenient to use than the tables.

In the mathematical functions plotted, γ, the ratio of specific heats of air has been taken to be 1.4 and μ, the coefficient of viscosity for dry air at 23° C, to be

(183.00 ± 0.25) micropoise. This coefficient is equivalent to $(37^{4.1} \pm 0.5) \times 10^{-9}$ slug/ft. sec. at the standard sea level temperature of 15° C. The upper limit of the Mach number of the flow has been fixed arbitrarily at 5.

The graphs have been grouped in sections labelled A. Isentropic Flow, B. Normal Shocks, C. Oblique Shocks, D. Conical Flow, E. Reynolds Numbers. Each section contains its own introduction in which the basic equations used for the graphs are derived and briefly explained. The derivations do not always start with first principles. Nevertheless the equations plotted are clearly stated as are the figures in which the corresponding graphs are to be found.

This book will be a valuable and useful tool for the engineers, physicists, and applied mathematicians working in compressible airflow.

A. H. T.

53[V].—K. G. TADMAN, *Tables of Flow Functions for Bodies of Revolution in Circular Tunnels and Jets.* Armament Research Establishment Memo 25/53 (modified). 11 mimeographed pages.

The functions defined by the following equations occur in the computation of irrotational incompressible flow patterns about bodies of revolution.

$$\phi(x, y, \nu, -1) + \frac{1}{2r} = \sum_{n=0}^{\infty} C_{\nu,n} \frac{r^n P_n(s)}{n!}$$

$$\phi(x, y, \nu, -2) + 1/2 \ln r(1 + s) = \sum_{n=0}^{\infty} C_{\nu,n-1} \frac{r^n P_n(s)}{n!}$$

$$1/2[r(1 + s)]^{-1} - \Omega(x, y, \nu, -2) = \sum_{n=0} C_{\nu,n-1} \frac{r^{n-1} P_n'(s)}{(n + 1)!}$$

$$1/4[\ln (r(1 + s)) - 1/2(1 - s)/(1 + s)] - \Omega(x, y, \nu, -3) = \sum_{n=0} C_{\nu,n-2} \frac{r^{n-1} P_n'(s)}{(n + 1)!}$$

where $r^2 = x^2 + y^2$, $s = x/r$, $P_n(s)$ is the Legendre polynomial of order n and the $C_{\nu,n}$ are constants given in the memorandum to six significant figures.

This memorandum contains tables giving the values of the right hand sides of these equations to six significant figures for the case $\nu = 0$. These values have been used in an investigation into boundary corrections for axisymmetric cavities formed in cylindrical free jets. They are applicable only in the case of a boundary which is a free stream function.

The following tables are also included:

Table V: $-J_0(k_{0,m}y)$ Table VI: $-J_1(k_{0,m}y)/k_{0,m}y$

Table VII: $-\exp(-k_{0,m}x)/k_{0,m}J_1^2(k_{0,m})$

where $k_{\nu,m}$ is the mth positive zero of the Bessel function $J_\nu(z)$.

A. H. T.

54[Z].—*Proceedings of the First Conference on Training Personnel for the Computing Machine Field.* Edited by Arvid W. Jacobson, Wayne University Press, Detroit, 1944. 104 pages. Price $5.00.

On page 81 of this volume, L. W. Cohen makes two observations. "First, the effective use of the computing machine depends on the development of appropriate mathematical methods. Second, the development of mathematical methods depends on the development of mathematicians."

The operators of various computing machines seem to be becoming more aware of these dependences, and Wayne University has tried to make information available in a series of summer programs. This book reports the second of these programs. It is divided into four parts with headings, *Manpower Requirements in the Computer Field*, *Educational Programs*, *Influence of Automatic Computers on Technical and General Education*, and *Cooperative Efforts for Training and Research.* In the first section an appraisal of manpower requirements in business and industry, in government agencies, and by computer manufacturers, is made by three contributors. Each of these contributors encourages educational institutions to increase their training programs or states his opinion that there will be a tremendous demand for university graduates trained in the sciences which pertain to the computing machine field.

In the second section of the book several contributors spell out generalities of educational programs. In the third part, there is considerably more detail in what various universities are doing in their training programs. The Massachusetts Institute of Technology lists Machine-aided Analysis, Digital Computer Coding and Logic, Numerical Analysis, Methods of Applied Mathematics, a second course in Numerical Analysis, Switching Circuits, Digital Computer Applications and Practice, Analog Computation, Electronic Computation Laboratory, Pulsed-data Systems, and Switching Circuits, as courses directly related to automatic computation, for example.

It would seem well for universities engaged in a training program relating to computing machines or contemplating such a program to look through this book to extract from the first part some ideas about the potential demand, from the second part some ideas about the general aims and content of the program, from the third part some ideas concerning appropriate courses, and from the fourth part some ideas concerning the possibility of getting help in supporting such a program.

It is unfortunately true that the universities will have a hard time finding suitable text material for these courses and capable instructors, for the demands reported in the book are consuming the time and the efforts of people who might otherwise be available to write texts and to instruct in this field.

C. B. T.

NOTES

Summary of Educational Opportunities in Electronic Computation

A tabulated summary of educational opportunities in electronic computation is being prepared by Professor H. H. Goode, Professor of Electrical Engineering, University of Michigan. This Electronic Computation Education Summary will be published in the *Transactions* of the Professional Group on Electronic Computers of The Institute of Radio Engineers.