116[G].—H. S. M. COXETER & W. O. J. MOSER, *Generators and Relations for Discrete Groups*, Second edition, Ergebnisse der Mathematik und ihrer Grenzgebiete, Band 14, Springer-Verlag, New York, 1965, ix + 161 pp., 24 cm. Price $8.00.

This is a revised version of the first edition, which appeared in 1957. For a brief review of the latter see that by G. Higman in *Math. Reviews*, v. 19, 1958, p. 527. The changes here are relatively small, but there is inclusion of further results on binary polyhedral groups, the groups $GL(2, p)$ and $PGL(2, p)$, and the Mathieu groups M_{11} and M_{12}. There is also mention of recent work on the Burnside problem and of some studies on electronic computers. It would appear that, so far, the use of computers has not changed the subject very significantly.

The 12 tables in the back of the book on non-Abelian groups, point groups, space groups, crystallographic groups, symmetric groups, reflexible maps, finite maps, regular maps, etc. are carried over unchanged from the first edition except that some of them, like the bibliography that follows, have been reset in a more spacious format.

The book remains, as before, the definitive work on the subject, and with its further improved and corrected text, and the new hard cover in which it is bedecked, it is one that the student of group theory will want to possess.

The reviewer agrees with the opinion in Higman's review that the study and knowledge of many specific groups forms a valuable basis for insight and inspiration concerning the general theory. The modern style is, of course, usually more abstract. It would be of value if some student of the psychology of mathematical invention would undertake a serious, quantitative study of the relative effectiveness of these two approaches.

D. S.

117[G, X].—L. FOX, *An Introduction to Numerical Linear Algebra*, Oxford University Press, New York, 1965, xi + 327 pp., 24 cm. Price $8.50.

This American edition differs from the earlier British edition [cf. the review by Ortega, *Math. Comp.*, v. 19, 1965, pp. 337–338] only in that 32 pages of exercises have been added. Some of these call attention to errors and ambiguities in the text. Mostly, however, they include a number of numerical examples, with small matrices usually of integer elements, and exercises providing commentaries on or extensions of the theory. All are fairly straightforward, and considerably enhance the value of the book, whether for self-study, or as a classroom text.

The Oxford University Press, Oxford, England has available copies of the exercises that can be obtained on request by those owning the British edition.

A. S. H.

118[H].—HERBERT E. SALZER, CHARLES H. RICHARDS & ISABELLE ARSHAM, *Table for the Solution of Cubic Equations*, McGraw-Hill Book Co., Inc., New York, 1958, xv + 161 pp., 21 cm. Price $4.50. Paperback (1963), $2.25.

The cubic equation $ax^3 + bx^2 + cx + d = 0$, by the substitution $x = y - b/3a$, is transformed to (1) $a'y^3 + b'y + c' = 0$, where $a' = a$, $b' = c - b^2/3a$ and $c' = d - bc/3a + 2b^3/27a^2$. The three roots of (1) are given by $(-c'/b')f_i(\theta)$, $i = 1, 2, 3$, where $\theta = a'c'^2/b'^3$ and

$$f_1(\theta) = \frac{[1 + \sqrt{1 + (4/27\theta)}]^{1/3} + [1 - \sqrt{1 + (4/27\theta)}]^{1/3}}{(2\theta)^{1/3}},$$

$$f_2(\theta), f_3(\theta) = -\frac{f_1(\theta)}{2} \pm \sqrt{\frac{f_1(\theta)^2}{4} - \frac{1}{\theta f_1(\theta)}}.$$

For $-4/27 < \theta < 0$, all roots are real; for $\theta > 0$ or $\theta < -4/27$, there is one real root and a pair of complex roots. By suitably different choices of the phase angle for the one-third powers, the function $f_1(\theta)$ is always made to be real (even though discontinuous at $\theta = -4/27$).

The present table gives $f_i(\theta)$, $i = 1, 2, 3$, for $1/\theta = -0.001(-0.001) - 1$, $\theta = -1(0.001)1$, $1/\theta = 1(-0.001)0.001$, to 7D everywhere except for $f_2(\theta)$ and $f_3(\theta)$, for $\theta = -0.148(0.001) - 0.001$, which are given to 7S. The accuracy is to within about a unit in the last place. First differences Δ are tabulated everywhere, and second differences Δ^2 wherever they are $\geqq 4$ units in the last place.

The introductory text contains the following material: comparison of (1) with the form (2) $y^3 + py + q = 0$, obtained by dividing through by a' (see below for an amendment of that section); discussion of related tables for solving cubics, with particular attention to those of H. A. Nogrady, B. M. Shumiagskii, and A. Zavrotsky; method of interpolation; illustrations of the use of the table, consisting of four examples worked out in complete detail; method of computation, which was on the Univac Scientific Computer (ERA 1103) for $\theta > 0$ and $\theta < -4/27$, and which was by desk calculator for $-4/27 < \theta < 0$.

For an efficient way to use this table to help to solve any quartic with real coefficients, by desk calculation, see H. E. Salzer, "A note on the solution of quartic equations," *Math. Comp.*, v. 14, 1960, pp. 279–281.

In 1958 the author-reviewer notified the publisher about some half-dozen minor printing defects, which are still present in the paperback edition (e.g., the absence of a page numbered 1). But just recently the author-reviewer noted the following misleading material in the paragraph on pp. vi–vii: It is stated there that when in (1) the a' is much smaller than b' or c' and given to much fewer significant figures, since p and q in (2) will be given to around the same relative accuracy as a', say e, the corresponding $\theta = q^2/p^3$ might have a relative error as large as $5e$ instead of the relative error of approximately e in $\theta = a'c'^2/b'^3$ corresponding to (1). It is also stated there that the factor $-c'/b'$ in $(-c'/b')f_i(\theta)$ leads to greater accuracy than the factor $-q/p$ corresponding to (2) because q and p have much greater relative errors than c' and b'. Now both these statements are true only if we retain about the same number of figures in p and q as occurs in a'. However, if in the division $p = b'/a'$, $q = c'/a'$, we retain the same, or one more, number of digits in the quotients p and q as are in b' and c' respectively, even though the p and q still have about the same large relative error e from the a', the computation of $\theta = q^2/p^3$ leads to the same accuracy as $\theta = a'c'^2/b'^3$, and the computation $-q/p$ will give the same accuracy as $-c'/b'$. Thus, if one takes the precaution of retaining sufficient numbers of figures in the divisions, the implication in that paragraph that (1) yields greater accuracy than (2) no longer holds.

HERBERT E. SALZER

156 Beach 125th Street
Belle Harbor 94, New York