

32 [9].—HERBERT HAUPTMAN, EMANUEL VEGH & JANET FISHER, *Table of All Primitive Roots for Primes less than 5000*, Naval Research Laboratory Report 7070, April 1970, Washington, D. C., v + 587 pp. May be purchased from U. S. Government Printing Office, Washington, D. C. Price \$4.25 (paperbound).

For each of the 668 odd primes $p < 5000$ there is listed the factorization of $p - 1$, the values of $\varphi(p - 1)$ and $\varphi(p - 1)/(p - 1)$, and each of the $\varphi(p - 1)$ positive primitive roots less than p .

There is a very brief introduction giving definitions, methods, references, and, primarily, conjectures concerning the distribution of the primitive roots. Thus: it is known that infinitely many primes have two consecutive primitive roots, but it has not been proven that all sufficiently large primes do. The authors suggest that one use of this volume is to study empirically such distribution questions.

The function $\varphi(p - 1)/(p - 1)$ is the density of the primitive roots in these modular systems, and I note that the lowest value attained here is 0.2078 for the two primes

$$2311 = 1 + 2 \cdot 3 \cdot 5 \cdot 7 \cdot 11 \quad \text{and} \quad 4621 = 1 + 4 \cdot 3 \cdot 5 \cdot 7 \cdot 11.$$

Queries. What is the distribution of these densities? Is there a positive lower bound?

The table was computed in 14 minutes. The photographic reproduction here is not perfect; a number of pages here and there are rather blurred.

For related reviews in this journal, see Osborn, RMT 18, v. 16, 1962, p. 252, and Western & Miller, RMT 51, v. 23, 1969, pp. 683–685.

D. S.

33 [10].—ROBERT RILEY, *FORTTRAN Program for the Computation of the First Integral Homology Group of 3-Dimensional Manifolds, Considered as Branched Covering Spaces of the 3-Sphere*, ms. of about 4 typewritten pages and about 12 computer sheets (reduced), deposited in the UMT file.

This is the homology routine described in Section 5 of [1]. The typewritten pages contain instructions for the use of the routine, and suggestions on how to modify the program for special purposes. In normal use, nothing will have to be modified except the specification of the array sizes, and the once-for-all setting of the largest permitted integer in the Fortran of the machine on which the program will be run.

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1. W. BURNSIDE, *Theory of Groups of Finite Order*, Cambridge Univ. Press, Cambridge, 1897.