is entitled " Girth ", the *girth* of a graph being the minimum of the lengths of all circuits in the graph. There is some interest amongst a number of graph-theorists in finding graphs, with given girth γ and with all vertices of given degree k, in which the number of vertices is minimal: detailed solutions are here discussed for $k=3$, $\gamma \leqq 8$. It is perhaps doubtful whether the title of the book is quite appropriate to Chapters 5, 7 and 8, but connectivity is certainly the theme of the subsequent chapters. The *connectivity* $\lambda(G)$ of a graph G is defined as the least integer k for which G is expressible as $H \cup K$, where H, K are subgraphs of G with at least k edges each (to exclude trivial partitioning of G) and with exactly k common vertices and no common edges. Thus G is separable, in the usual sense, if and only if $\lambda(G) \leqq 1$. Chapter 9 deals with separability and non-separability and with the tree-like decomposition of a separable (connected) graph into its cut-components, blocks or cyclic elements (depending on the terminological school to which one belongs). Thus one might say that Chapter 9 focuses attention on the distinction between graphs with connectivity $\leqq 1$ and those with connectivity $\geqq 2$. The contents of Chapters 10-12 might be roughly described by saying that they present a somewhat analogous theory in which the important distinction is between graphs with connectivity $\leqq 2$ and those with connectivity $\geqq 3$.

Much of the material included seems to be the product of the author's own research, which the book will help to make more accessible. The book is to be commended for its precision: concepts are exactly defined and theorems are stated exactly and proved exactly, and Professor Tutte thus avoids the sort of intuitive woolliness to which some graph-theorists are too prone. If two further volumes are in fact planned, these, like the present one, will indeed be valuable additions to the literature.

C. ST. J. A. NASH-WILLIAMS

PALEY, HIRAM AND WEICHSEL, PAUL M., *A First Course in Abstract Algebra* (Holt, Rinehart and Winston, 1966), xiii+334 pp., $8.95.

The authors give a lucid account of the topics in abstract algebra normally included in an honours course. Chapters 1 and 3 deal with the basic properties of sets, relations, functions and permutations, while Chapter 2 is devoted to number theory. Chapters 4 and 5 cover the elementary theory of groups and rings. Some more advanced topics in group theory, including the basis theorem for finitely generated abelian groups, the Sylow theory, the elementary theory of soluble groups, and free groups, are treated in Chapter 6, while Chapter 7 is devoted to a similar treatment of ring theory, among the topics covered being field extensions, finite fields, and projective and injective modules.

The first five chapters, together with a selection of topics from Chapters 6 and 7, would make an excellent honours course in abstract algebra.

J. M. HOWIE

CHIH-HAN SAH, *Abstract Algebra* (Academic Press, Inc., New York, 1966), xiii+342 pp., 78s.

As a potential text for a course in a British university, this book falls rather uncomfortably between two stools, containing as it does rather too much advanced material for undergraduates and rather too much elementary material for postgraduates.

The book would, however, make an excellent supplementary reference for a good honours student: it contains a development of elementary number theory from Peano's axioms and a nearly completely algebraic proof of the fundamental theorem of algebra, as well as many other topics of interest to undergraduates and for which there rarely seems to be time.

The scope of the book is enormous. It seems nearly incredible that so much could be packed into 342 pages, and while the style is certainly concise, it does not seem

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unduly contracted. In group theory the topics covered include the Sylow theorems, transitive permutation groups, the simplicity of A_n for $n \geqq 5$, automorphisms of finite symmetric groups, and the basis theorem for finitely generated abelian groups. An introductory chapter on ring theory then prepares the ground for a detailed study of modules over a commutative ring, which in turn leads naturally into a concise and (for a student's book) unusually sophisticated account of finite-dimensional linear algebra; this last part would certainly be found hard by a student approaching the subject for the first time. Chapters VII and VIII cover the theory of fields up to the proof of the insolubility of the quintic equation, while the final chapter is devoted to the already mentioned proof of the fundamental theorem of algebra.

Throughout the book the viewpoint is fairly sophisticated, or " modern ". Maturer mathematicians will enjoy the new look it gives to familiar topics. J. M. HOWIE

KRISHNAIAH, PARUCHURI, K. (Editor), *Multivariate Analysis* (Academic Press, 1966), xix+592 pp., 156s.

This is a well-produced book consisting of papers presented at the International Symposium on Multivariate Analysis held in Dayton, Ohio in June 1965. The list of contributors (thirty-nine in all) is formidable and contains a host of very well-known names.

Papers are divided in the book into eight different categories under the following headings: non-parametric methods, multivariate analysis of variance and related topics, classification, distribution theory, optimum properties of test procedures, estimation and prediction, ranking and selection procedures, applications. Thus the coverage of the field is very wide and the wealth of material in the book is such that few professional statisticians would find nothing of special interest in it. Moreover its organisation ensures that it provides an excellent reference book for both recent and past developments in multivariate analysis, so that it is a most useful, if somewhat expensive, addition to the literature in this field. S. D. SILVEY

LEHNER, JOSEPH, *A Short Course in Automorphic Functions* (Holt, Rinehart and Winston, London, 1966), vii+144 pp., 40s.

This is a short introduction to the theory of automorphic functions and discontinuous groups. It is primarily a text for beginners in the subject, although more mature mathematicians will find it an excellent place to learn the connection of the theory of Riemann surfaces with the theories of automorphic functions and discontinuous groups. In the past this has been a one way process, but lately there has been a marked increase in the application of the latter theories to the former. There are three chapters: Discontinuous groups, Automorphic Functions and Forms, and Riemann Surfaces. The first chapter develops the basic facts about linear fractional transformations, discontinuous groups and fundamental regions of discontinous groups. Poincaré's model of hyperbolic geometry is introduced and the existence of fundamental regions is proved by the normal polygon method. The lower bound for the hyperbolic area of a fundamental region is obtained. Chapter 2 starts with the development of Poincaré series and the existence of automorphic forms is thereby demonstrated. The Petersson inner product is introduced for the vector space of cusp forms and Hecke's beautiful theory of T_n operators is sketched. The last chapter develops the connection with Riemann Surface theory.

This book is not without defects. I noted several gaps in proofs which for the most part are easily filled. Most beginners will find that the material on fundamental regions requires careful reading. There is an unfortunate omission in the bibliography. On page 65 Professor A. M. Macbeath's lectures on Discontinuous Groups at the 1961 Summer School in Geometry and Topology at Dundee are mentioned