

likely to be strictly limited while absolute conformity to dialectic materialism and subservience to the needs of production remain. The most important function of the Academy, he considers, is to help the Government implement its various policies, but he describes at some length the relation of science to Soviet ideology and the wider orbit of the work of the Academy in training future scholars, sponsoring scientific conferences and popularizing science. In his last three chapters, Prof. Vucinich reviews briefly the place of the Academy in the Five-Year Plans, and in the social structure, and the implications of ideological purification of the supremacy of technology, and of total planning on the future development of Soviet science. Ample bibliographical references to the chapters and the appended lists of the Academy's scientific research organizations, of the academies in the Union Republics, of academicians and of periodicals of the Academy add to the value of the study as a contribution to the current debate on the implications of Soviet science and technology for Great Britain and the West in general.

R. BRIGHTMAN

POOR RELATIONS

Ordinal Algebras

By Prof. Alfred Tarski. With appendices by Chen-Chung Chang and Prof. Bjarni Jónsson. (Studies in Logic and the Foundations of Mathematics.) Pp. v+133. (Amsterdam: North-Holland Publishing Company, 1956.) 27s.

RELATIONS have never been popular. They were utterly ignored by Aristotle and other logicians until they were introduced into logic by A. de Morgan and C. S. Pierce nearly a century ago. Mathematics uses many relations; for example, a function is a many-one relation. Apart from a few elementary definitions and easy deductions, no general theory of relations has appeared, they have never been the sole subject of a study, and there is no book about the theory of relations. Certain relations have been studied in more or less detail, such as the equality, equivalence and order relations, and in algebra and topology various morphisms. More detailed results have been obtained for well-ordering relations in the theory of ordinal numbers and semi-ordering relations in the theory of lattices. But all these form very narrow classes of relation types. The only general results consist of definitions of certain fundamental operations on relations and their most obvious consequences. For non-binary relations there is practically no literature.

Tarski has for some years been interested in the general theory of relations and this book is a beginning of a general theory of binary relations. He considers the first task is to develop the arithmetic of relation types, that is, the study of operations by means of which the isomorphism types of complicated relations can be obtained from those of simpler ones. One of the fundamental arithmetic operations on relation types is relational addition. This operation is performable on an arbitrary system of relation types which are indexed by the elements of the field of a given relation. The main purpose of this monograph is just to develop the theory of ordinal addition for arbitrary relation types.

The method adopted is to develop abstract algebraic systems formed by a set A of arbitrary

elements, an operation Σ on finite or simple infinite sequences of elements of A , an operation $+$ on couples of elements of A , an operation \times on single elements of A , and a distinguished element 0 of A . A certain class of such algebraic systems in which the elements and the operations satisfy some simple postulates of an arithmetic character are called ordinal algebras. The first chapter deals with consequences of these postulates.

In Chapter 2 it is shown that the postulates defining an ordinal algebra are satisfied if we take A for the set of all reflexive relation types, for Σ and $+$ the known operations of ordinal addition, for \times the operation of conversion, and for 0 the empty relation.

There are two appendixes: the first, by Chen-Chung Chang, contains the solution of some arithmetical problems formulated in Chapter 1. The second, by Bjarni Jónsson, deals with the general operation of relational addition. It introduces the notion of a relation type which cannot be represented as a sum of relation types over a relation belonging to a set A , unless all the terms of the sum except one are equal to 0 . The main result is to prove that every reflexive relation type can be uniquely represented as a sum of indecomposable types over a relation belonging to the set A , provided A satisfies certain general conditions.

Here then is a beginning of a general theory of relations; who can tell how far it will go?

S. W. P. STEEN

RADIATION SHIELDING OF NUCLEAR REACTORS

Reactor Shielding Design Manual

Edited by Theodore Rockwell. Pp. xii+472. (Princeton, N.J.: D. Van Nostrand Company, Inc.; London: Macmillan and Co., Ltd., 1956.) 42s.

IN the past six years an extensive corpus of experimental results and methods of calculation for reactor shielding problems has been amassed in laboratories attached to the Naval Reactors Branch of the United States Atomic Energy Commission, and the existence of several shielding reactors in America has made possible a detailed study of many shield systems. This and much other work, previously unpublished or available in report form only, is summarized in this five hundred page manual.

The technique of reactor shielding falls into three parts: first, the determination of the sources of radiation in the reactor and in materials activated by its neutron flux; secondly, the choice of shield materials on the basis of their nuclear properties as attenuators; thirdly, the engineering design of the chosen materials to form a shield of least cost, weight or size. The book is arranged in the order in which it might be used in the design of a power reactor shield. After chapters on shielding theory and health physics, the shielding of core and coolant systems is treated successively. There are separate sections on shield engineering, the effect of voids, shut-down radioactivity and plant layout; experimental results and useful mathematical results are tabulated in the last two chapters, and this edition has a short index.

The merit of this manual is that it contains virtually all the available information required to