retical physics buff will find many things of interest here, whatever his tastes may be.

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Analysis and Control of Linear Systems, by Y. H. Ku. 458 pages, diagrams, 6 × 9 in. Scranton, Pa., International Textbook Co., 1962. Price, $10.00

Professor Ku states in his *Preface*, "This book has been written to provide electrical and mechanical engineers with a fundamental treatment of feedback control systems. The material here presented can serve as a text for an undergraduate course in control engineering. Since feedback control is a rapidly developing field, this text can well serve as the basis of a first year graduate course."

The accuracy and scope of this text is a direct reflection upon the knowledge and authority of its writer. Its exposition is clear and precisely stated and the context logically developed.

Chapter 1 discusses the nature of linear physical systems, and electrical and mechanical analogs, with reference to mathematical representation of physical systems. Block diagrams and signal flow graphs are introduced. Chapter 2 deals with linear network analysis. Chapter 3 gives a treatment of Laplace transforms as required for linear control systems. Chapter 4 gives the frequency response method and the Bode diagram. The Nyquist criterion, the Routh-Hurwitz criterion and root-locus method treated in Chaps. 5–7 are well-illustrated with many numerical examples. Also Chap. 6 gives the solution of algebraic equations by Cardan's method for the cubic equation, Ku's method and Ferrari's method for the quartic equation, and Graeffe's method and Lin's method for higher-order algebraic equations.

Control system performance in the frequency domain—static error-coefficients, phase margin, gain margin, bandwidth and the maximum modulus—are discussed in Chap. 8. Chapter 9 includes an account of control system performance in the time domain (determination of overshoot, the peak time, rise time, delay time, optimum performance criteria, and Floyd's method and Guillemin's method for determining transient response from frequency response). Chapter 10 gives an introduction to control system synthesis, determination of the closed-loop system function to satisfy prescribed performance specifications, and compensation by use of lead, lag, lead-lead, lead-lag networks.

Chapter 11 treats concisely some of the control system components (thermal, hydraulic, pneumatic, and mechanical; gyroscopes, d-c machines, a-c servomotors, a-c tachomotors, selsyns and metadynes).

The five appendices comprise a large number of student-exercise problems; a table of Laplace transforms; network synthesis by use of Legendre, Laguerre, and Hermite polynomials; Lyapunov's approach to stability and performance of non-linear control systems; and a new method of determining the functions of hysteresis-type non-linear elements.

Each major aspect of the general theory is illustrated by numerical examples, and short pertinent lists of books for further reading are included.

The book's many fine features and the quality of the writing (the author having produced several other well-received books: "Electric Energy Conversion," N. Y., Ronald Press, 1959; "Analysis and Control of Nonlinear Systems," Ronald Press, 1958; "Transient Circuit Analysis," N. Y., D. Van Nostrand, 1961) render this an excellent work for an in-plant or after-hours course for young engineers or for the practicing engineer wishing to supplement his knowledge of the field in an easily-followed text for self-study.

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A Theory of Sets, by Anthony P. Morse. Vol. 18: Pure and Applied Math Series. 130 pages, diagrams, 6 × 9 in. New York, Academic Press Inc., 1965. Price, $7.95.

The most concise way to characterize this new theory is to quote from p. 41:

"We believe every (mathematical) thing is a set. We believe there is no difference between the conjunction of two or more things and their intersection. We believe there is no

difference between the disjunction of two things and their union. We believe there is no difference between the negation of a thing and its complement. We have come to believe a thing if and only if the empty set is a member of the thing. We believe $(x \in y)$ if and only if x is a member of y. We believe $(x \in y)$ if and only if $(x \in y)$ is the universe. We disbelieve $(x \in y)$ if and only if $(x \in y)$ is the empty set."

This means that the distinction between propositions and sets, between false and void has been dropped. Each set is true or false, and each sentence names a set. 1(the set with the unique element 0) is true since $0 \in 1$; (0, 1) (ordered pair) is false.

$$\bigvee x \in 3((0 \in x) \wedge \underline{u}x)$$

if and only for some x in 3, 0 is in x and $\underline{u}x$,

$$\bigvee x \in 3((0 \in x) \wedge \underline{u}x)$$

equals the union as x runs over 3 of the intersection of $(0 \in x)$ with $\underline{u}x$.

In Chapter I, *Logic*, the intuitive meaning of 0 is "false"; and in Chap. II, *Set Theory*, it is "void". U which by formal definition means non-0, can be interpreted as "true" and as "universe". So among the axioms of set theory one reads: $(x \leftrightarrow (0 \in x))$, $((t \in U) \rightarrow ((t \in (x \in y)) \leftrightarrow (x \in y))$.

It looks exotic, like eating with sticks, though in some parts of the world they would call forks exotic.

In any case, it is exciting and the excitement is enhanced by many remarkable details and by the author's marvellous style.

It is a pity that for this excitement one has to pay the usurious price of struggling through Chap. 0, or the even higher one of deciding whether or not to throw it away.

Chapter 0, *Language and Inference*, sets forth the meta-mathematics. It explains what theorems are and, still more important, what a formula is. This is done with painstaking care—more than is usually bestowed upon meta-mathematics. Maybe the new system *needs* more, though the reviewer wonders whether this need could not have been met in a better way. Written with little regard for the poor reader, Chap. 0 is a forbidding introduction to the superbly lucid Chaps. 1 and 2.

Usually meta-mathematics is presented in a constructive setting. The author prefers an axiomatic approach, his axioms being called rules. There might be reasons for doing this, though the reviewer can think of none. However, the main and perplexing point is the lack of didactic care. Any axiomatic approach to number theory or geometry presupposes a reader who intuitively knows what numbers and points are. Here a hundred odd notions are introduced, most of them new and strange, and the crucial ones in an implicit setting.

On p. 5 it is said that a *form* is essentially the left member of a definition. However, there is no previous explanation as to which kind of expressions are definitions, since according to p. 3 each definition is explicitly described or introduced later. So actually one has to read all definitions up to p. 111 to know what a form looks like. True, there is an Appendix on "The Construction of Definitions", but unfortunately it starts even later, on p. 113.

When the word *formula* appears the reader is still more perplexed: "A is a *formula* if and only if some variable is free in A." Freeness of a variable had been previously explained for forms only. So this sentence is not an "agreement" as asserted by the author, but a "rule", stating implicitly what kind of expressions will be allowed to be formulas. Upon reading further, one notices many more rules to restrict the idea of formula, and while desperately trying to disentangle a thicket of implicitness, one still asks "how many?".

The reviewer had difficulty understanding Chap. 0. Nevertheless, Chaps. 1 and 2 were thoroughly enjoyable and are highly recommended.

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LINEAR STATISTICAL INFERENCE AND ITS APPLICATIONS, by C. Radhakrishna Rao. 522 pages, diagrams, 6 × 9 in. New York, John Wiley & Sons, 1965. Price, $14.95.

C. R. Rao would be found on almost any statistician's list of the five outstanding research workers in the world in mathematical statistics today. His book represents a comprehensive account of the main body of results that comprize modern statistical theory.

Two long introductory chapters provide the mathematical background needed beyond a broad knowledge of advanced calculus. Vector spaces, matrices, determinants, convex sets,