high-speed electronic calculator STRELA at the Computational Center of the Academy.

The Russian work has been concerned with the functions $P_{-1/2+i\tau}(x)$, where τ is real and $x > -1$. The functions are real, and satisfy the differential equation

$$(1 - x^2)u'' - 2xu' - (\tfrac{1}{4} + \tau^2)u = 0.$$

The functions occur in potential problems relating, for example, to cones and hyperboloids of revolution; they also occur in the Mehler-Fock inversion formulas [1]. The tables for $-1 < x < 1$ and $x > 1$ are given in Volumes I and II, respectively. The formulas given in the Introduction to Vol. I are limited to those which have some application in the range $-1 < x < 1$. The values were computed from

$$P_{-1/2+i\tau}(x) = F(\tfrac{1}{2} - i\tau, \tfrac{1}{2} + i\tau; 1; \tfrac{1}{2} - \tfrac{1}{2}x),$$

where $F(a,b;c;z)$ denotes the hypergeometric function, and were checked by differencing. The main table (pages 13–312) gives values of $P_{-1/2+i\tau}(x)$ to 7S for $\tau = 0(0.01)50$, $x = +0.9(-0.1)-0.9$, without differences. (It is stated that Vol. II, which the reviewer has not seen, gives values for $x = 1.1(0.1)2(0.2)5(0.5)10(10)60$.) The interval in τ has been made narrow because applications in mathematical physics frequently require integration with respect to τ. It is stated that interpolation in τ may be performed by the three-point Lagrange formula with an error not exceeding 1.6 final units; it may be added that such an error can occur in only a small part of the table. Interpolation in x is naturally more troublesome, even well away from a logarithmic singularity at $x = -1$.

An auxiliary table on pages 315–318 facilitates use of an asymptotic series for large τ; arc cos x and four coefficients which are functions of x are tabulated to 7D for $x = 0.99(-0.01)-0.90$, without differences. Values of the Bessel functions I_0 and I_1 are required to be available for use with the auxiliary table.

A useful bibliography of 16 items averages about one misprint per item in the five non-Russian titles, the most entertaining being MacRobert's well-known book on "Spherical Harmonies" and a paper by Barnes on "Veneralized Legendre Functions."

The reviewer differenced about a hundred values without finding any error. Assuming its accuracy, this must be reckoned a valuable table.

A. F.

1. A. Erdélyi et al, *Higher Transcendental Functions*, Vol. 1, McGraw-Hill, New York, 1953, p. 175.

23 [X].—A. Charnes & W. W. Cooper, *Management Models & Industrial Applications of Linear Programming*, v. 1, John Wiley & Sons, Inc., New York, 1961, xxiii + 471 p., 26 cm. Price $11.95.

This book is addressed to persons interested in the application of linear programming techniques to various aspects of management planning. Much of the material has been published previously by the authors in scattered journals and texts; however, this volume offers the advantage of a unified mathematical treatment of sundry topics in mathematical programming and managerial economics within the framework of adjacent-extreme-point techniques.

The earlier parts of this volume do not require mathematics beyond college algebra. The rudiments of linear programming theory and techniques are illustrated by means of simple numerical examples. An elementary machine loading problem is introduced to elucidate such concepts as linear model formulation, approximation of model types by scaling, the dual linear programming problem, and data accuracy and program sensitivity. The stepping-stone method for the classical Hitchcock transportation problem and transshipment problem are described at length. The procedure for dealing with degeneracy is also discussed. To explicate the concept of input-output analysis, a three-industry input-output model as an example of a "static, open Leontief model" is given. Feasible solutions are obtained by the Gauss elimination method.

With the exception of the transportation algorithm, a rigorous mathematical treatment of the foregoing topics are presented in the succeeding parts of this volume. Background material from the fields of matrix algebra, convex sets, and linear systems are developed and interpreted to provide an essentially self-contained account of the mathematics relevant to the managerial applications covered in the rest of the volume.

Considerable attention is devoted to Dantzig's simplex method for solving the general linear programming problem. The basic simplex algorithm is carefully explained and illustrated with the aid of numerical examples and geometrical interpretations. Additional by-products and interpretations are obtained, such as the extension of the simplex calculations for analyzing the effects of altering (a) the stipulations vector, (b) the coefficients of the objective function, and (c) the structural vectors. Also, the role of the simplex procedure as a tool for securing proofs of several important duality theorems in the field of linear inequalities is deftly portrayed.

The application of delegation models to managerial economics is first examined along the lines of T. C. Koopman's "activity analysis models." A major purpose of such models is the determination of rules which might be applied to guide the activities of a decentralized management organization. Koopman's formulation is reduced to a series of special linear programming problems and their duals. "Efficient" solutions are obtained by the "spiral" method. Koopman's concept of "efficiency" is then generalized to provide under certain circumstances more suitable criteria for managerial applications.

Linear programming approaches to statistical problems involving inequality relationships are delineated and applied to a problem of determining an executive-compensation formula for an industrial concern. Moreover, the techniques employed to solve this problem provide an introduction to the use of adjacent-extreme-point methods to a variety of nonlinear problems encountered in management planning. Modifications of simplex criteria and procedures are developed for the case where a functional subject to linear constraints may be decomposed by linear transformations into a sum of functionals involving only a single variable. The basic shortcoming of this approach is that, in general, only a local optimum is guaranteed.

A dynamic model for production scheduling at minimum cost when the costs are unknown is solved by means of "surrogate" techniques and "subhorizon" methods. Optimizing rules are enumerated and expounded for solving an actual example for which these methods were first devised. This is followed by a proof of the optimizing properties of the rules. The effects of introducing costs, such as inventory charges, and additional constraints, such as storage limitations, are touched upon from the standpoint of possible variations in the length of sub-horizons. A generalized approach to this class of problem is explored via the Kuhn-Tucker theorem for nonlinear programming.

The "classical" models of linear programming are presented with commendable clarity. Moreover, the adaptation of linear programming methods for solving nonlinear types of management problems is aptly demonstrated. However, this reviewer's enthusiasm was tempered by the fact that the present edition abounds with errors resulting from an apparent cursory attempt at editing and proofreading. This reviewer recommends that the publishers prepare an errata sheet; otherwise, the intolerable number of typographical errors will vitiate the intrinsic merits of this book as a textbook and reference.

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24 [X].—ROMAN JAKOBSON, Editor, *Proceedings of Symposia in Applied Mathematics*, Vol. XII, "Structure of Language and its Mathematical Aspects," American Mathematical Society, Providence, 1961, vi + 279 p., 26 cm. Price $7.80.

Sponsored by the American Mathematical Society, the Association for Symbolic Logic, and the Linguistic Society of America, and cosponsored by the Institute for Defense Analyses under an Office of Naval Research contract, the symposium, held in April, 1960, included the following papers:

W. V. Quine	Logic as a Source of Syntactical Insights
Noam Chomsky	On the Notion "Rule of Grammar"
Hilary Putnam	Some Issues in the Theory of Grammar
Henry Hiż	Congrammaticality, Batteries of Transformations and Grammatical Categories
Nelson Goodman	Graphs for Linguistics
Haskell B. Curry	Some Logical Aspects of Grammatical Structure
Yuen Ren Chao	Graphic and Phonetic Aspects of Linguistic and Mathematical Symbols
Murray Eden	On the Formalization of Handwriting
Morris Halle	On the Role of Simplicity in Linguistic Descriptions
Robert Abernathy	The Problem of Linguistic Equivalence
Hans G. Herzberger	The Joints of English
Anthony G. Oettinger	Automatic Syntactic Analysis and the Pushdown Store
Victor H. Yngve	The Depth Hypothesis
Gordon E. Peterson and Frank Harary	Foundations in Phonemic Theory
Joachim Lambek	On the Calculus of Syntactic Types
H. A. Gleason, Jr.	Genetic Relationship Among Languages
Benoit Mandelbrot	On the Theory of Word Frequencies and on Related Markovian Models of Discourse
Charles F. Hockett	Grammar for the Hearer
Rulon Wells	A Measure of Subjective Information
Roman Jakobson	Linguistics and Communication Theory