Academy of Sciences is already outdated.

Despite the book's overall excellence, the two chapters that treat nonmedical topics are weak. Beijerinck's contributions are certainly given inadequate treatment, and not a single line of Kluyver's work is quoted. The development of knowledge of alcoholic fermentation subsequent to Buchner's contribution, the key problem from which modern microbial biochemistry developed, is completely ignored. The prehistory of modern microbial genetics, starting with the controversy between pleomorphists and monomorphists and passing through the argument between the Darwinians and Lamarkians among the bacteriologists, is unmentioned. The names of important figures in general microbiology —T. W. Engelmann, Marjorie Stephenson, S. Orla-Jensen, C. B. van Niel, and E. G. Pringsheim, among others— are missing from the index. This criticism is not aimed at omissions; in my opinion the book would have been improved by more omissions— the two chapters in point. Though perhaps it is better as is, because some general microbiologist with damaged ego may feel compelled to repair the hiatus and present us with a companion volume.

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Science Surveys Series

Analysis and Synthesis of Linear Time-Variable Systems. Allen R. Stubberud. University of California Press, Berkeley, 1964. viii + 108 pp. Illus. $4.75.

This book, the first in a series called *Science Surveys* prepared under the general editorship of Edwin F. Beckenbach (University of California, Los Angeles), is based on the Ph.D. dissertation of Allen R. Stubberud at the University. The principal results reported in the book appeared in 1962 and 1963 in journal articles by Stubberud. However the book is an integrated treatment and includes some background material.

The book is clearly written and easy to follow. The reader is presumed to have a working knowledge of elementary differential equations, which most engineering and science undergraduates do have. However, the actual application of the methods developed involves a substantial amount of arithmetic and calculations.

The emphasis is on preliminary synthesis, which in this instance consists of obtaining the analog computer diagram corresponding to a differential equation or weighting function. All initial conditions are assumed to be zero so that input-output relationships of systems are of primary concern. A key to the development of analysis and synthesis of linear systems is an algebra for treating arbitrary interconnections of such systems. Such an algebra is developed by the author. Among the possible subsystem or component representations, the author chose the single nth order differential equation relating input and output variables. Owing to the noncommutativity of linear time-varying differential operators, the problem of obtaining the overall, single differential equation relating the system input to the system output is computationally involved. The author's algebra systematizes manipulations of systems of equations corresponding to the subsystems. However, the arithmetic is still enormous.

In this book Stubberud does not consider the algebra for system interconnections when each subsystem is represented by a set of first-order, linear differential equations rather than a single high order linear differential equation. Using the alternative representation (W. R. Perkins, "Synthesis of interconnected linear time-varying systems," to be presented at the National Electronics Conferences, October 1965, Chicago, Ill.) results in a vast simplification of the algebra and arithmetic over the one used by Stubberud.

If one is forced to use the single nth order representation, then Stubberud's algebra is quite helpful, but if there is no pressing reason for this choice, the n first-order representation should be used because much less computation is involved. Because the book contains other background material it should be worthwhile reading for students of system theory.

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Astrophysics

Dynamics of Stellar Systems. K. F. Ogorodnikov. Translated from the Russian edition (Moscow, 1958) by J. B. Sykes. Arthur Beer, Translation Ed. Pergamon, New York, 1965. xii + 359 pp. Illus. $15.

The first half of *Dynamics of Stellar Systems* presents the classical material dealing with kinematics (velocity ellipsoids, velocity centroids, and the like), the Oort-Lindblad theory of galactic rotation, irregular forces, and integrals of the motion (with a discussion of isolating integrals). Students will find that this is a valuable treatment which complements other books on stellar dynamics. The second half is concerned wihh a number of dynamic problems and strongly reflects the author's approach to an understanding of the present structure of stellar systems. The book is not highly mathematical, and emphasis is placed on discussion of the physical concepts.

The so-called synthetic method is the foundation of Ogorodnikov's theory, and this begins with the assumption that there are strong relaxation mechanisms working in galaxies which lead to a statistically unique quasi-steady state. This mixing is assumed to be the result of the existence of a large number of star clouds in the mass range 10^5 to 10^6 suns, which constitute about 10 percent of the total mass of a galaxy. The author uses the hydrodynamic equations for a description of the dense inner regions of galaxies, with velocity dispersions obtained from the single-valued integrals of the motion. In this way closure of the hydrodynamic equations is formally obtained. The synthetic method combines the continuum and statistical approach to the problem.

Not all of those who work in the field of stellar dynamics will agree with some of the author's ideas and techniques—for example, some will be worried by such a large number of postulated massive star groups (and massive clouds). Others will express some concern over the use of the hydrodynamic equations without an examination of the magnitude of the next higher order moments of the Boltzmann equation. And it is not a strong test of any theory that agreement can be obtained with some observed luminosity profiles of galaxies.

If this book is used as a textbook,

then it is clear that a great deal of additional material must be presented by the instructor. There is virtually no discussion of the accuracy of observational techniques used to obtain luminosity profiles, rotation curves, and the like. Stellar populations receive scant mention. More fundamental is the fact that there is no discussion of the formation of stellar systems. This is rather disappointing because it is an alternate approach to an understanding of the present structure of stellar systems. Despite these limitations, the book will serve students and research workers as a valuable reference source.

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Explorations of the Niger River

Missions to the Niger. vol. 1, *The Journal of Friedrich Hornemann's Travels from Cairo to Murzuk in the Years 1797–98* [and] *The Letters of Major Alexander Gordon Laing, 1824–26*. E. W. Bovill, Ed. Published for the Hakluyt Society by Cambridge University Press, New York, 1964. xiv + 406 pp. Illus. $7.50.

This is the first volume of a short series in which the Hakluyt Society hopes to publish the accounts of explorations of the Niger River in the period after its discovery by Mungo Park. Although Hornemann's journal and Laing's letters appear here in a single volume, their juxtaposition is due to the length of the material available rather than to any other affinity between them. But perhaps it is right that they are joined together. Both men sought the Niger, but neither ever traveled along it. Both died in their search. Hornemann reached Nupe where he died of fever. Laing was killed after he had left Timbuktu, the first European to reach that goal during the great era of exploration. Neither ranks among the great European explorers of Africa, although this may be due in part to their lack of luck rather than to their abilities. Hornemann's papers were destroyed after his death, probably during the Fulani conquest of Nupe. Perhaps little of vital importance was lost, for he seems to have lacked the acute interest in people and their affairs and in the details of the land that marks so many of the great explorers. Much more was lost when Laing's journal disappeared, either at the site where he was killed or in the hands of the courier sent to transmit to it Tripoli. What little is known about his journey from Tripoli to Timbuktu has had to be pieced together from his letters.

The travel accounts in the volume are therefore of minor interest to historians of Africa and to geographers and others. Nevertheless the Hakluyt Society has performed a very useful service in making the material available. Hornemann's account, originally published in 1801, has not appeared in an English edition since 1802. Laing has never received any extended treatment by an English biographer. E. W. Bovill, who has edited the volume, has done a meticulous job of describing the explorers and placing their work in the context of the history of time. His editing has created a biography and running account of Laing's exploration out of a series of disconnected letters. Historians of West Africa may be able to ignore the journal of Hornemann and the letters of Laing, but they would be very well advised to look at the introductions and annotations of Bovill.

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University Mathematical Texts

Numerical Methods. vols. 1 and 2. vol. 1, *Iteration, Programming, and Algebraic Equations* (168 pp., $3); vol. 2, *Differences, Integration, and Differential Equations* (224 pp., $2.75). Ben Noble. Oliver and Boyd, London; Interscience (Wiley), New York, 1965.

In Britain the pocket-size volumes of this series hold a high reputation as lucid introductions to the basic notions of a subject. This new title continues the tradition.

It is uncanny how the editors of the series continue to find authors who can illuminate, in only two or three pages, the content of entire chapters written by more pedestrian authors.

The method is classical, almost inevitable. Select in each area one topic that embodies the important ideas, explain it fully and well, eschew generality (that bane of textbooks), and provide good problems. The result is an admirable text for a college course in numerical analysis at the junior or senior level (or below), or for self study.

Volume 1 covers iteration, programming, and algebraic equations. As an illustration of the choices that the author makes we can cite chapter 2. Apart from the usual general description of iterations, only the methods of Newton-Raphson and Bairstow are described in detail. But the reader is introduced to the effect of uncertainty in the given function, to the concept of ill-conditioning, and to the fact that it is the accuracy with which the function can be evaluated which determines the limiting accuracy of the calculation. None of these ideas are brought out in, for example, Hartree.

There is an excellent introduction to programming in which the author explains the essentials of a stored program machine and introduces a self-explanatory, informal, coding language. In subsequent chapters there is good emphasis on the problems involved in turning a mathematical method into an adequate algorithm.

The chapter on simultaneous linear equations (direct methods) does not use matrix notation, which is introduced in the next chapter. The last chapter covers the power method for finding eigenvalues and also the methods of simultaneous and successive displacements (Jacobi and Gauss-Seidel) for solving matrix equations iteratively. The volume closes with a discussion of overrelaxation for tridiagonal matrices since, in this case, the important relation between the eigenvalues of the two iteration matrices involved can be obtained in an elementary manner.

Volume 2 covers differences, integration, and differential equations. Tchebychev approximations and Tchebychev expansions are mentioned briefly, but an entire chapter is devoted to Lagrangian interpolation. Runge-Kutta and predictor-corrector methods for solving ordinary differential equations are covered quite fully, with clear distinctions made between the various possible causes of unsatisfactory results.

These two volumes are excellent teaching companions for use with *Modern Computing Methods* (Her Majesty's Stationery Office, London), whose bibliography is frequently cited by the author.

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