matical techniques, and with special emphasis on the physical meaning of the results. It is agreeable to find how much can be learnt about nonlinear systems using undergraduate mathematics, when knowingly applied.

Magnus classifies oscillations in terms of their mechanism of generation—proper oscillations (normal modes), self-excited oscillations, parametric oscillations, forced oscillations, and coupled oscillations. Each of these is described with reference to a variety of physical examples, and, wherever appropriate, both energy and plane considerations are presented. The examples presented in the text, as well as those given as exercises, are almost entirely of mechanical origin, with only a sprinkling of hydraulic and electromechanical problems. While the motions thus presented certainly span the gamut of important oscillations, it would have been valuable to have at least mentioned more of the electrical and electronic systems which have led to much of the present-day interest in the topics discussed here.

It is quite safe to say that the variety of topics discussed in this book, and the usable information presented about them, cannot be rivaled in any other book of this level or size, currently available, or indeed in many weightier and more profound tomes. In view of its modest size (250 pages) and the clarity of presentation, it seems unfair to quibble about the omission of even a brief discussion of the important stability criteria (Routh and Liapunov) and of the work of Pontriagin and others on adaptive systems. This book should not only prove useful to anyone interested in applications, but provides a desirable complement to the more abstract and elegant mathematical works dealing with stability.

Nonlinear Differential Equations. By Raimond A. Struble. 267 pp. McGraw-Hill Book Co., Inc., New York, 1962. $7.50. *Reviewed by Peter L. Balise, University of Washington.*

ALTHOUGH nature is nonlinear, the intractability of nonlinear differential equations has caused physical systems to be largely represented by linear models. Now, nonlinear theory is becoming very important, not only for more accurate representation of natural phenomena, but because deliberate introduction of nonlinearities, especially in automatic controllers, makes possible much better performance. Several recent nonlinear-systems books reflect the need for such applied analysis.

This volume, however, is definitely a mathematics text, concerning theory rather than physical systems, but it is distinguished by the author's regard for the needs and limitations of nonmathematicians. While appropriate for a senior or graduate mathematics course, it should also be a good reference for scientists and engineers. Dr. Struble attractively emphasizes the understanding of concepts and omits details which might be appropriate in a mathematics text but which would obscure the main ideas. And he includes brief introduc-

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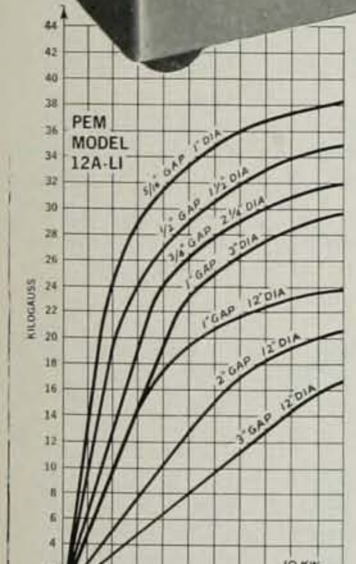

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tory explanations that should be helpful even to the mature readers for whom the book is intended.

Accordingly, the phase-space concept is presented at the beginning, illustrated by the pendulum with Newtonian damping, probably the most effective elementary example of the transition from linear to nonlinear behavior. The phase plane is given considerable attention throughout, although not as much as the engineer or scientist might desire. Background is provided by early chapters on linear equations and existence and uniqueness theorems. Although only one chapter is entitled "Stability in Nonlinear Systems," the last half of the book is devoted primarily to this centrally important topic. It is good to see that Dr. Struble presents Lyapunov's "second method", the principal analytical tool for studying nonlinear stability problems in the Soviet Union, now being introduced in the United States. He also gives considerable attention to Poincaré stability and mentions Laplace stability.

There is now no general approach to nonlinear problems, and the variety of nonlinearities makes a single unifying method seem unlikely. There is much need for mathematical treatments like Dr. Struble's, as well as for important approximating techniques like the describing function (which he does not mention). And this will remain true even as simulation of nonlinear systems by analog and digital computers obviates the necessity for complete analysis.

Eigenfunction Expansions Associated with Second-order Differential Equations, Part 1 (2nd ed.). By E. C. Titchmarsh. 203 pp. Oxford U. Press, New York, 1962. $6.75. *Reviewed by George Weiss, University of Maryland.*

THIS is the second edition of a mathematical treatise of some interest to physicists. Several chapters have been rewritten and there is now some reference to the work of Levitan. Unfortunately the work still remains forbiddingly difficult to read and only analysts of a high order will be able to appreciate it.

Singularities of Linear System Functions. By Bernhard Gross and Elde Pires Braga. 90 pp. American Elsevier Publishing Co., Inc., New York, 1961. Paperbound $4.00. *Reviewed by Robert J. Rubin, National Bureau of Standards.*

ALTHOUGH this little book is written in the language of electrical network theory, it is of interest to students and specialists in the fields of dispersion-relation theory, crystal-lattice dynamics, dielectric relaxation, and viscoelastic behavior, where the underlying mathematical structures are identical. The properties of linear networks can be characterized in terms of the singularities in the complex frequency plane of functions such as the driving-point impedance, which in turn is related to the diagonal element of a Green function for the network. In this book several specific examples of linear networks are examined in detail.