Dealing with the digital explosion

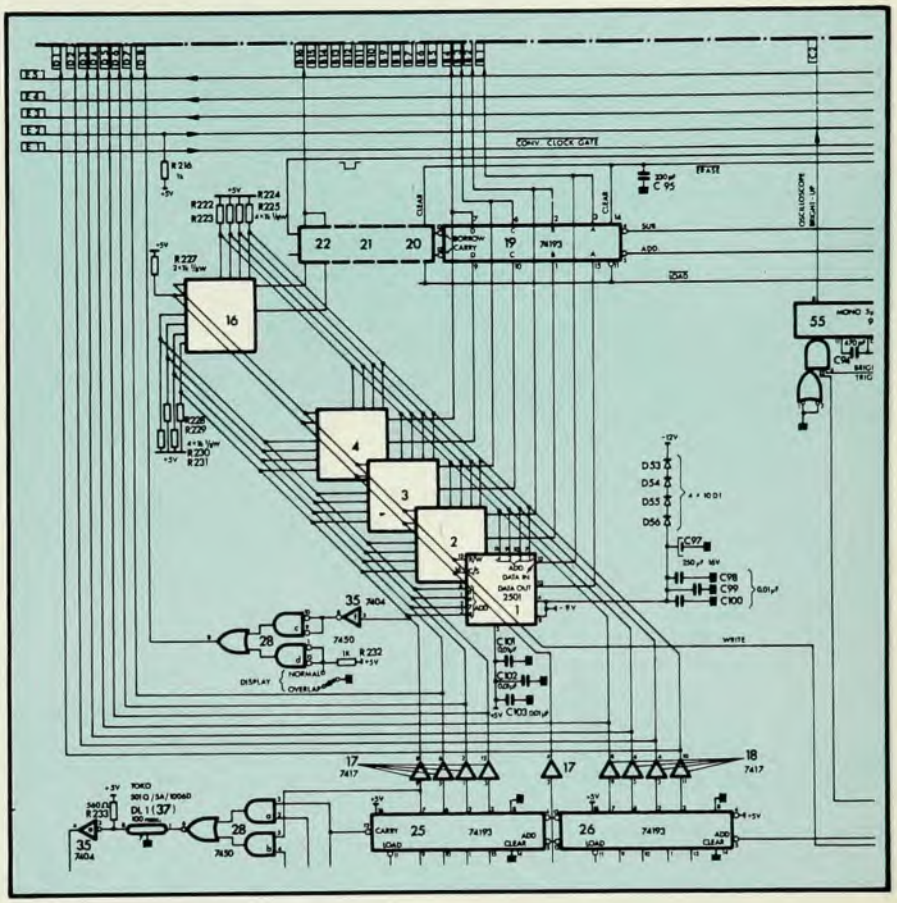
Digital Signal Processing

A. V. Oppenheim, R. W. Schafer
585 pp. Prentice-Hall, Englewood Cliffs, N.J., 1975. $21.95

Theory and Application of Digital Signal Processing

L. R. Rabiner, B. Gold
762 pp. Prentice-Hall, Englewood Cliffs, N.J., 1975. $27.50

Reviewed by B. R. Hunt



The publication by Prentice-Hall of two new books in digital signal processing is a welcome addition to the literature in this field. Digital circuits are springing up everywhere in modern laboratories, the result of two separate trends. The first trend is the appearance of digital hardware for carrying out some of the common data and signal processing operations likely to be found in experiments in physics, chemistry, optics, and so on. As a consequence, one can buy digital laboratory equipment for analysis of, for example, mechanical vibration spectra, transient signal averaging, and photon imaging at low-light levels. The second trend is the use of digital computers to control experimental assemblies, including acquisition and logging of all experimental results. As a result, no one plans a complex experimental facility (for example, the LAMPF linear accelerator at Los Alamos) without including digital control and data acquisition as part of the basic design.

Although digital signal processing was initially applied to certain military radar and communication problems, it appears clear that the experimental sciences will benefit much from this technology. There are some inherent benefits to digital processes, such as greater noise immunity, rapid change of system characteristics in filtering and editing data and control of significance in computations. But the digital revolution now underway is equally attributable to intense economic competition among manufacturers of solid-state integrated circuits, logic components and minicomputers. The resulting increases in power and decreases in price have brought digital signal processing within the reach of most laboratories.

Digital Signal Processing, by Alan V. Oppenheim and Ronald W. Schafer, is an excellent introduction to the general subject, suitable for use either as a text in a graduate curriculum or as a primary source or reference for the practicing scientist. The introductory chapters give lucid and very readable coverage of such basic topics as: discrete-time systems theory and mathematics, the properties and use of the z-transform, the discrete Fourier transform and its use in digital filtering, the fast Fourier transform algorithm, recursive and nonrecursive digital filters, processing of random signals, etc. There are also chapters on topics that are often not adequately discussed, such as: effects of using a finite number of data representation bits, special algebraic concepts that can be used to simplify nonlinear signal-processing problems, and the estimation of covariance functions and power spectra from random data. In general, the book gives careful treatment of the basic theoretical and mathematical questions of importance.

Theory and Application of Digital Signal Processing, by Lawrence R. Rabiner and Bernard Gold, is the ideal companion to the book by Oppenheim and Schafer. With minimal redundancy in introductory material, the reader who has finished Oppenheim and Schafer's book can pick up Rabiner and Gold's and find in-depth coverage of most of the problems that will confront the user or designer of systems for digital signal processing. For example, there are chapters on the detailed design of digital filters (including some programs for filter response optimization), the nature of hardware for digital signal processing (including discussion of special hardware for the fast Fourier transform and general hardware for laboratory implementations of digital signal processing) and specific details for application of digital signal processing

to speech and radar signal processing.

Both books were written by the right pairs of individuals. Oppenheim and Schafer are professors of Electrical Engineering (at MIT and Georgia Tech, respectively), and the pedagogical touch in their book is just right. Rabiner and Gold are industrial research scientists (at Bell Labs and Lincoln Lab, respectively), and the practical problems of implementation are appropriately emphasized. All four authors are well known and widely respected for their research contributions to the field of digital signal processing.

The increased usage of digital computers and digital components in laboratory equipment appears to imply that many experimental scientists are going to find themselves confronting the problems of digital signal processing. These two books should form the basic library for anyone faced with such problems: Oppenheim and Schafer for the basic concepts and theory, and Rabiner and Gold for practical implementations and advanced concepts.

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Angular Momentum Theory for Diatomic Molecules

B. R. Judd
238 pp. Academic, New York, 1975. $22.50

This book represents a rather successful attempt to introduce to molecular spectroscopists the extensive tensorial formalism developed historically for treating angular-momentum problems in atoms. Brian Judd has been an active research worker for some years in applying tensorial methods to atomic problems, and his thorough understanding of his own field evidently lies at the root of the particularly clear writing and the careful choice of a surprisingly large range of examples of significant interest to the molecular spectroscopist. Examples discussed include: the rigid rotator, Friedrich Hund's coupling cases in a $^2\Phi$ state, the electronic structure of the hydrogen molecular ion, the fine-structure Hamiltonian for the hydrogen molecule in a $^3\Pi_u$ state, nuclear quadrupole splittings in a $^3\Pi_{0u}$ state of the iodine molecule, Λ-type doubling in a $^3\Pi$ state, Stark and Zeeman effects, diamagnetic shielding, and others.

The book is skillfully pedagogical. Readers with no previous exposure to the subject can clearly benefit from the text, especially since the first chapter is devoted to such topics as rotation matrices, spherical tensors, the Wigner–Eckart theorem, and 3-j, 6-j and 9-j symbols. Significant benefits for the previously unexposed will undoubtedly require, however, some effort directed toward solving the problems at the end of each chapter.

Readers with previous knowledge of the subject will be delighted by the detailed discussions of the examples chosen, and by the up-to-date and extensive references. Some familiarity with group theory is supposed. In fact, readers without a good understanding of the continuous rotation group in three dimensions may have difficulty with the discussions of the continuous rotation group in four dimensions, which play a significant role in treating various topics throughout the book.

This reviewer's only criticism of the volume is perhaps more in the nature of a warning. Because tensorial notation is so compact, so powerful, and so widely applicable, it is often possible to derive formally admissible but physically incorrect results, primarily as a result of paying insufficient attention to the connection between the physics of the situation and the mathematics that is to mirror this physics. In the hands of an experienced worker no such misfortune need arise. But Judd's clear exposé may tempt others, after acquiring only a superficial knowledge, to venture forth on their own in uncharted waters. Such voyages are not uniformly successful.

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Course of Theoretical Physics, Volume 4: Relativistic Quantum Theory

V. B. Berestetskii (part one only), **E. M. Lifshitz, L. P. Pitaevskii**
616 pp. Addison-Wesley, Reading, Mass., 1971 (part one), 1973 (part two). $16.00 (part one), $12.50 (part two)

These books will sell well because they constitute volume 4 in the "Landau–Lifshitz" course in theoretical physics. Owners of volumes 1, 2, 3, 5, 6, and so on will not find it possible to resist putting volume 4 in its proper place.

Unfortunately, the Landau–Lifshitz series is not the proper place for these books. I suppose this is partly because of the absence of Landau, but even more because of the nature of the subject matter. The authors observe