found wide-spread application, and not only in the field of automatic control.

Thus it is very important for engineers and scientists to have a book like Brammer's which gives a unified approach to linear filtering theory as well as to the theory of observers.

The first chapter of the book *Kalman–Bucy Filter*, written by K. Brammer, is devoted to the observation problem for continuous and discrete-time linear systems. This includes a discussion of observability, controllability, and the principle of duality. Chapter 2 starts with the discrete Kalman filter which is demonstrated to be the recursive version of a Gauss-Markov estimator, i.e., a weighted least-squares estimator with known *a priori* statistics. Next, the equations of the continuous Kalman–Bucy filter are developed by a limiting procedure using the matrix Wiener–Hopf integral equation. The close relations of the Wiener filter, the Kalman–Bucy filter, and the deterministic observer are pointed out. Then special cases like additional inputs and the prediction problem are considered.

Chapter 3 deals with practical questions that arise by implementing the observer or the filter in a closed-loop control system; this leads to algebraic or stochastic separation. Moreover, the case of colored plant and measurement noise and the possibility of reducing the order of the estimator are discussed. Finally, an outlook on the Itô stochastic calculus and nonlinear filtering theory, as well as an appendix on matrix calculus, is presented.

Brammer's book gives an excellent account of linear filtering theory. The author's way of developing the optimal filter with the Gaussian least-squares method by adding, step by step, more and more statistical *a priori* information enables easy understanding of the theory for the newcomer to the field and makes pleasant reading for the expert.

For deeper understanding of filtering, some knowledge of probability theory and stochastic processes is necessary. This knowledge is available by reading the volume *Stochastische Grundlagen des Kalman–Bucy Filters*, written by G. Siffling, which completes Brammer's book.

Siffling first gives a survey of the state space representation of linear dynamic systems. Then the concept of probability is introduced following the axiomatic definitions of Kolmogoroff; random variables, probability functions, expected values, and stochastic processes are discussed in a comprehensive way. The last chapter is devoted to the problem of transients in linear systems with stochastic inputs. Finally, the same appendix on matrix calculus as in Brammer's book is presented.

Siffling doubtless has succeeded in writing, in a comparatively few pages, a clear introduction to a subject which is not easily accessible to the newcomer. Therefore, his book should be of considerable interest to students as well as engineers who want to work on stochastic processes and filtering theory.

References

[1] R. E. Kalman, "A new approach to linear filtering and prediction problems," *Trans. ASME*, series D, 82, pp. 35–45, 1960.
[2] R. E. Kalman and R. S. Bucy, "New results in linear filtering and prediction theory," *Trans. ASME*, series D, 83, pp. 95–108, 1961.

Control Systems Engineering—I. J. Nagrath and M. Gopal (New Delhi: Wiley Eastern, 1975, 491 pp., Rs. 20.25 (about $3). *Reviewed by Vimal Singh, Department of Electrical Engineering, Motilal Nehru Regional Engineering College, Allahabad 211004, India.*

This book deals with the topics of a typical undergraduate course in control engineering. It contains twelve chapters.

Chapter 1 (11 pp.) clarifies the idea of feedback through examples such as those pertaining to servomechanisms, multivariable systems, and nonengineering applications. Chapter 2 (41 pp.) describes system modeling (differential equations, transfer functions, block diagrams, and signal-flow graphs). Chapter 3 (18 pp.) gives an account of feedback characteristics with emphasis on sensitivity to parameter variations and disturbance signals. Chapter 4 (36 pp.) describes some important electrical, hydraulic, and pneumatic control systems and components. Time-response analysis (41 pp.), the stability concept and the Routh–Hurwitz criterion (16 pp.), the root-locus technique (41 pp.), frequency-response methods (30 pp.), the Nyquist criterion and closed-loop frequency response (42 pp.), and compensation techniques (57 pp.) form the contents of the next six chapters.

Chapter 11 (58 pp.) deals with the state-variable approach to system characterization and some related concepts such as controllability and observability, linear regulator design, and state-variable feedback design. In the last chapter (62 pp.), which is about nonlinear systems, the authors have discussed in some detail the phase-plane and describing-function methods of analysis, after explaining phenomena such as limit cycle, jump resonance, subharmonics, and the characteristics of common nonlinearities occurring in practice.

Some basic analytic tools, such as the Laplace transform, partial-fraction expansion, matrix algebra, and the procedure for determining the roots of characteristic equations, appear in the form of appendices at the end.

The book contains illustrative examples in numerous places. One finds, chapterwise, a good collection of student exercise problems (answers supplied). Some occasional mistakes are not unlikely, however. For instance, this reviewer felt some doubt about Answers 2.13, 2.15, and 2.16.

As a whole, the book is quite impressive and, no doubt, serves the purpose for which it is written.

Introduction to Digital Filtering—R. E. Bogner and A. G. Constantinides, Eds. (London: John Wiley, 1975, 198 pp.). *Reviewed by R. C. Agarwal, IBM Thomas J. Watson Research Center, Yorktown Heights, NY 10598.*

This book is an outcome of the post-experience courses on digital filtering given at Imperial College, London. This is a collection of lectures on digital filtering from eight contributing authors. This book is particularly useful for practicing engineers who are already familiar with analog filters and would like to make use of modern digital filtering techniques for their applications. The material is presented concisely and covers all the important aspects of digital filtering. The mathematics used in the book is simple and easy to understand. A number of examples are given to show conversion from analog to digital filters. Adequate references are given for further in-depth study of the subject.

Chapter 1 gives the motivation for using digital filters. Sampling, the z-transform, and the relationship between s-plane and z-plane are covered in Chapter 2. In Chapter 3, characteristics and realization of digital filters are considered. Conversion of existing analog filters to equivalent digital filters, using bilinear transformation from s-plane to z-plane, is given in Chapter 4. Chapter 5 deals with the direct synthesis of recursive digital filters in z-plane. Finite impulse response (FIR) filters are described in Chapter 6. Discrete Fourier transform (DFT), its properties, the fast Fourier transform (FFT) algorithm used to compute the DFT, digital convolution and FIR filter implementation using the FFT, and power spectrum estimation are discussed in detail in Chapter 7. Frequency-sampling filters are discussed in Chapters 8 and 9. Chapter 10 discusses the effects of quantization of coefficients and arithmetical round-off errors on the performance of digital filters. Finally, some optimization techniques for the design of FIR filters are considered in Chapter 11.

One of the drawbacks of the book is that most of the developments in digital filtering after 1971 have been omitted. Recently, there have been some significant contributions, particularly in FIR filter design techniques, which should have been included. Overall, this book serves an important purpose in introducing the important and fast-developing area of digital filtering to those who are unfamiliar with it.