Book Reviews

Estimation Theory with Applications to Communication and Control—Andrew P. Sage and James L. Melsa (New York: McGraw-Hill, 1971, 529 pp.)

The preface of this book states that "this text provides a comprehensive treatment of estimation theory with applications to communications and control." Further, the statement is made that "the text is written by engineers for engineers." The book achieves these stated goals and is quite adequate for a course in estimation theory or a text for the practicing research engineer.

The first chapter briefly introduces estimation theory and outlines the material presented in succeeding chapters. Chapters 2, 3, and the first half of 4 provide a general review of probability theory, random variables, and stochastic processes with emphasis on Gaussian processes. They are well written (as are the remaining chapters) and are necessary background for the development of estimation theory. The basic concepts of probability are dealt with in Chapter 2, including algebraic operations on random variables and expectations. Chapter 3 extends the probability theory concepts into the study of stochastic processes. The format is that of a review with the exception of a very important and detailed section on linear system responses. The first part of Chapter 4 delineates some special concepts involving Gauss–Markov processes. The central limit theorem is developed along with multivariate Gaussian processes. A person well grounded in probability theory can eliminate the reading of these chapters.

Chapter 5 develops decision theory using both Bayes risk and Neyman–Pearson criterion. Two sections are devoted to sequential detection theory and point out the close relationship between estimation and decision theory.

The most important material in the book is contained in Chapters 6–9. Bayesian estimation theory is developed along with maximum likelihood methods in Chapter 6. Sections on pseudo-Bayes estimators, error analysis, and least-squares curve fitting are given. This chapter provides an excellent introduction to the subject of estimation theory, and the relationships presented are fundamental to the understanding of modern estimation theory in the remainder of the text. Chapter 7 gives a clear and concise presentation of the basic development of the discrete and continuous Kalman filter. Its relationship to the Wiener filter is detailed and the asymptotic behavior discussed. Chapter 8 extends the optimum linear filter to include colored noise inputs, prediction algorithms, and fixed-point, fixed-lag, and fixed-interval smoothing algorithms. An error and sensitivity analysis is conducted in some detail and the divergence problem is discussed. Chapter 9 gives explicit consideration to problems in nonlinear estimation. The approach develops around a derived modified Fokker–Planck equation. Maximum *a posteriori* estimation algorithms for both the discrete and continuous cases are derived along with a linearized Kalman filter. Comparisons of the various algorithms are made, and as an extension nonlinear smoothing algorithms are developed.

Overall the book represents an excellent contribution to the estimation theory area. Many example problems are given that provide varied applications in the communication and control fields. Some mathematical rigor is ignored, but the general presentation of the material is clear and concise, and the title adequately describes its contents.

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Diakoptics and Networks—Harvey H. Happ (New York: Academic Press, 1971, 312 pp.)

The principal content of this book is the exposition of the contour theory of networks. While some of the material is contained in the author's series of papers in the IEEE Transactions on Power Apparatus and Systems, this book is the first comprehensive treatment of the contour theory as developed and applied by Happ. It consolidates the published material and gives greater theoretical detail, covering more general combinations of network excitations than those needed in the analysis of power systems.

The contour theory of networks leads to a class of orthogonal linear transformations which transform the fundamental branch (or primitive) Ohm's law equations of the network into a new set of equations incorporating Kirchhoff's laws which can be solved for all network currents and voltages for any given excitation. These new equations relate currents following specified open and closed contours through the network to the voltages measured along these contours. The solution algorithms derived from the contour theory and the associated orthogonal transformations encompass the commonly used solution algorithms based on singular connection matrices. The well-known singular connection matrices, such as those relating node currents to branch currents or loop voltages to branch voltages, are shown to be submatrices of the orthogonal transformation matrices. The use of the contour theory and orthogonal transformations serves to unify a large body of material on network solution techniques.

The author gives careful attention to the relationship between the way in which the contours are routed through the graph of the network and the location of the current and voltage sources in the network. It is pointed out that the characteristics of the network in terms of its open and closed path contour equations depend not only on the interconnection of the branches, but also on the location of the current and voltage sources in relation to the location of the contours. This point is of great importance to the designer of network solution programs for digital computers because the efficiency of computation can be significantly enhanced by taking proper advantage of both network topology and source locations when selecting contours and setting up the network equations.

While the orthogonal network theory gives a useful and instructive unification of network solution techniques in general, the principal application covered by Happ in this book is the development of piecewise network solution algorithms or diakoptics.

In piecewise-solution algorithms a large network is solved by dividing it into several smaller networks, solving each subnetwork independently, and then applying a final "correction" to the independent solutions to account for the presence of interconnections between the subnetworks. The piecewise-solution methods outlined in this book follow from a special selection of open and closed path contours in the network and are of closed-form type, with no iterations being needed to satisfy conditions at the boundaries between subnetworks. The treatment of diakoptics in this monograph is brief and serves to point out the application of the theory, but not to give complete procedural details of piecewise algorithms.

The general organization and manner of presentation used by the author are theoretical in nature. Numerical examples and problems are included, and a number of figures have been used to illustrate the construction of the network transformation matrices, but there are no flow