Nomenclature for Flowchart of Fig. 2

I, J, K, L, M, N	Running indices.
$NSMP$	Sample size.
$X(\cdot)$	Random number sequence representing random variable X.
$Y(\cdot)$	Random number sequence representing random variable Y.
$Z(\cdot)$	Random number sequence used as a parent source to generate $Y(\cdot)$.
RH	Desired value of correlation coefficient, (ρ_d).
XM	Mean value of $X(\cdot)$, $(\bar{X})$.
ZM	Mean value of $Z(\cdot)$ is mean value of $Y(\cdot)$, $(\bar{Y})$.
XS	Standard deviation of $X(\cdot)$, (σ_x).
ZS	Standard deviation of $Z(\cdot)$ = standard deviation of $Y(\cdot)$, (σ_y).
EY	Best linear predictor of Y for given X, $[E^*(Y \mid X)]$.
DIF	Squared error, (q^2).
A	Some constant, large enough so that inequality $DIF > SDIF$ (i.e., $DIF > A$) is not satisfied at the first encounter.
$ER1$	Error bound for positive error is $D_1^2 \cdot \sigma_y^2(1-\rho_d^2)$.
$ER2$	Error bound for negative error is $D_2^2 \cdot \sigma_y^2(1-\rho_d^2)$.

If the distribution is symmetric about the mean then $ER1 = ER2$.

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Book Reviews

Optimum Systems Control—A. P. Sage and C. C. White, III (Englewood Cliffs, NJ: Prentice-Hall, 1977, 2nd ed., 413 pp.). *Reviewed by George M. Siouris, Aerospace Guidance and Metrology Center (AFLC), Newark Air Force Station, Newark, OH 43055.*

This authoritative book is the second edition of Professor Sage's "Optimum Systems Control," providing a concise and timely analysis of optimal control theory. Since the appearance of the first edition almost ten years ago, optimum systems control theory has developed into a full-fledged area of study. As everyone who has worked in this area knows, its applications span a wide spectrum of scientific disciplines. Seen in this context, it is indeed a pleasure to welcome the second edition, which is undoubtedly another contribution to the optimal control theory. The present volume has been reduced from the first edition's 562 pp. to 413 pp. It has been completely revised, and the treatment is more geared for the engineer. The revisions have improved and modernized the overall presentation by the addition of new material.

The concepts presented in the second edition are well motivated and only introduced after sufficient justification has been given and provide a well-balanced blend of theory and practical applications. The text takes the student step-by-step through every aspect of modern control theory. At the end of each chapter there are many exercises of varying degree of difficulty for the student to work out and test his mastery of the material presented. Moreover, the text is amply illustrated with completely worked-out examples, which gives it an added dimension as a text.

The present edition is divided into ten chapters. The first chapter defines the problems of deterministic optimum control, state estimation, stochastic control, parameter estimation, and adaptive control, which arise in optimum systems control. A short summary of the subsequent chapters is also given. Chapter 2 provides an introduction to the calculus of extrema of two and more variables. Entitled "Calculus of Extrema and Single-Stage Decision Processes," the chapter discusses such familiar topics as unconstrained extrema, extrema of functions with equality constraints, and nonlinear programming. In Chapter 3, the authors treat the classical calculus of variations. Topics discussed include dynamic optimization without constraints, transversality conditions, sufficient conditions for weak extrema, unspecified terminal time problems, the Euler–Lagrange equations and transversality conditions, dynamic optimization with equality constraints and Lagrange multipliers, and dynamic optimization with inequality constraints. In the classical sense, the problem is to find the particular functions $y(x)$ and $z(x)$ which minimize (or maximize) the integral $I = \int_{x_1}^{x_2} f(x, y, y', z, z')\, dx$ subject to the constraint $\phi(x, y, y', z, z') = 0$. The general form of the transversality condition then takes the form $[(F - \sum_{j=1}^{n} y_j' F_{y'_j})\, dx + \sum_{j=1}^{n} F_{y'_j}\, dy_j]_a^b = 0$ where $F = f + \sum_{i=1}^{m} \lambda_i \phi_i$ and $\phi_i = 0$ $(i = 1, \cdots, m)$. With regard to modern optimal control theory, one is interested in minimizing the cost function $J(x) = \int_{t_0}^{t_f} \phi[x(t), \dot{x}(t), t]\, dt$ on the interval $[t_0, t_f]$. Chapter 4 is a natural extension of Chapter 3 where more general solutions are obtained. In particular, this chapter covers the Pontryagin maximum principle, the Weierstrass–Erdmann conditions, the Bolza problem with and without inequality constraints, and the Hamilton–Jacobi equations and continuous dynamic programming. All the topics addressed are handled very well, and the authors are on solid ground. Chapter 5 deals with optimum systems control examples. In this chapter an attempt has been made to illustrate those optimal control problems for which closed-loop solutions exist. The linear regulator, the linear servomechanism, the bang-bang control and minimum time problems, and singular solutions are dealt with in some detail. The treatment of the linear servomechanism problem should appeal to the control engineer.

Chapter 6 discusses the discrete variational calculus and the discrete maximum principle. The technique developed in this chapter is of considerable importance. Discrete algorithms are easier to manipulate by hand, and they are more amenable to digital computer computations. Starting with the derivation of the discrete Euler–Lagrange equations, the authors proceed methodically to develop the discrete maximum principle, then compare the discrete and continuous maximum principle showing that the computational solutions are essentially the same, and finally investigate discrete optimal control and mathematical programming. Chapter 7 is the major coverage in the book which gives a valuable insight into the systems concepts. Outstanding in this chapter are the sections on sensitivity in optimum systems control and stability (both in-the-small and in-the-large). The remaining sections discuss observability in linear dynamic systems, and controllability in linear systems. Chapter 8 contains an account of optimum state estimation. This chapter develops the well-known Kalman–Wiener computational algorithms for nonstationary linear filtering. The modern approach of the "Kalman filter" is amenable to nonstationary recursive estimation problems where the signal to be estimated is the output of a dynamic time-varying linear system driven by white noise. Again here, and from this reviewers experience, the authors have done a fine job in presenting the material in terms that an engineer can understand. After a few mathematical preliminaries, the chapter covers the state-space formulation for systems with random inputs and minimum error variance linear filtering, the continuous-time and discrete-time Kalman filter, and the reconstruction of the state variables from output variables. The "Luenberger observer" is also treated briefly here. Chapter 9 is entitled "Combined Estimation and Control—the Linear Quadratic Gaussian (LQG) problem." After a general discussion, the chapter is devoted to the LQG problem for discrete and continuous cases, extensions of the LQG problem, and sensitivity analysis of combined estimation and control algorithms. All of these topics are treated in depth and detail. The last chapter, Chapter 10, contains several methods for solving optimal control problems. This is an excellent chapter for it summarizes the various computational methods available to the engineer. The computational methods discussed are discrete dynamic programming; gradient techniques for single-stage and multistage decision processes; optimization based on the second variation; and quasilinearization of continuous-time, discrete-time, and solutions of two-point boundary-value problems.

The book contains four useful appendices, which may serve as a reference to the student. Appendix A discusses the algebra, calculus, and differential equations of vectors and matrices. Appendix B is devoted to "Abstract Spaces." Appendix C treats random variables and stochastic processes. Appendix D develops the matrix inversion lemma. A well-documented list of references is provided at the end of each chapter.

This book is unique and invaluable and presents a balanced view of this many-sided subject. Thus the spectrum of backgrounds for the interested readership of this book is very broad indeed. The major merit of this book is that it successfully combines simplicity, physical intuition, and the ability to perform concrete calculations. There are some typographical errors, but the careful reader can easily detect them. The authors of this book provide an up-to-date well-written account of optimum systems control. For the reader who seeks an understanding of optimum systems control, this book can be highly recommended.

Power System Control and Stability—P. M. Anderson and A. A. Fouad (Ames, IA: Iowa State Univ., 1977, 464 pp.). *Reviewed by H. H. Happ, General Electric Company, Schenectady, NY 12345.*

This is volume 1 of a planned two-volume series on the subject. This book is without question the most outstanding text that has appeared on the subject of power system stability since the classic texts published more than 30 years ago. It is a well-written and detailed book that can serve as a classroom text as well as a reference volume. The book is at an advanced level and is therefore most suited for graduate work and as a reference source for practicing engineers and experts on the subject.

The book consists of nine chapters, five appendices, and an index. Numerous problems for homework appear at the end of each chapter as well as references for further study. Chapter 1 is entitled "Power System Stability" and serves to introduce the problem, the necessary definitions, and methods of solution. Chapter 2, entitled "The Elementary Mathematical Model," reviews the swing equations, the power-angle curve of a simple two-machine system, the classic representation of a synchronous machine in stability studies, and the equal area criterion still viewed as basic to this day. In Chapter 3, the system response to small disturbances is studied; a state-space approach is nicely introduced in this chapter by extending the conventional analysis of a simple machine against an infinite bus to a multimachine system.

The next three chapters consider detailed aspects of synchronous machine theory and their modeling. Chapter 4 presents a comprehensive summary of synchronous machine theory. Both exact as well as simplified models are derived. Chapter 5 entitled "The Simulation of Synchronous Machines" covers more practical considerations in the use of mathematical models such as the determination of initial conditions, how to obtain the required machine parameters from typical manufacturers' data, and the actual manner synchronous machines are modeled in both analog and digital simulations. Linear synchronous machine models are covered in Chapter 6. The following two chapters (7 and 8) discuss excitation systems and their effect on stability. An excellent summary of simplified to the sophisticated excitation systems is presented in Chapter 7. The effects of excitation on stability when a system is subjected to severe impacts (transient stability) as well as to small disturbances (dynamic stability) is covered in Chapter 8; the chapter also discusses supplementary stabilizing signals to improve system damping.

The last chapter, Chapter 9, covers multimachine systems. In this chapter, the authors chose to treat the loads as constant impedances for purposes of simplicity, which is justifiable for the purpose of this text. Both classic as well as more detailed machine representations are included. Five appendices and an index complete this superb text.

Optimization Methods—K. V. Mital (New Delhi: Wiley-Eastern, 1976, 253 pp.). *Reviewed by Vimal Singh, Department of Electrical Engineering, Motilal Nehru Regional Engineering College, Allahabad 211004, India.*

This book is an elementary introduction to optimization methods in operations research and systems analysis. It contains ten chapters. The first two chapters are about some related mathematical preliminaries such as Euclidean space, linear algebraic equations, convex sets, quadratic forms, and extrema of functions. The remaining chapters cover the main topics: linear programming, transportation problem, flow and potential in networks, nonlinear convex programming, dynamic programming, geometric programming, theory of games, and direct search and gradient methods. Only deterministic problems have been discussed.

The discussions are clear and to the point and, wherever necessary, illustrated by examples. The book contains, at the end of each chapter, a good number of unsolved problems.

The book contains 68 references all of which are books; the standard ones connected with the subject matter of a particular chapter are indicated in the form of a bibliographical note at the end of the chapter. Historical notes appear frequently. Thus the reader comes to know about the pioneer workers in the field.

The book is essentially self-contained, and most of the chapters can be studied independently of each other. Of course, it is assumed that the reader has some background in algebra, matrices, calculus, and geometry.

This book can serve as a suitable text for students of mathematics, operations research, engineering, economics, and management.