94[P, X].—M. R. HESTENES, *Calculus of Variations and Optimal Control Theory*, John Wiley & Sons, Inc., New York, 1966, xii + 405 pp., 24 cm. Price $12.95.

This book, by an eminent author whose contributions to the calculus of variations date from 1930 and who wrote in 1950 on the Maximum Principle, will be used and cited for many years.

Emphasis is on first-order necessary conditions for a variety of problems leading to the general control problem of Bolza. Other necessary conditions and sufficient conditions are treated for some of the simpler problems. The approach is classical in the sense that admissible state variables x are of class D', admissible control variables u are piecewise continuous and integrands f together with left members φ of side-conditions are of at least class C'. The Lebesgue integral is used only in the appendix and in occasional brief remarks.

There is an appropriate treatment of fields and Hamilton-Jacobi methods, needed for various manifestations of the Maximum Principle. That this topic, as well as the foundations of Dynamic Programming, as applied to variational problems, is an extension of classical Hamilton-Jacobi theory and not a separate subject becomes clear.

The book is not a survey of the current status of variational theory. There is very little on parametric problems, since control problems are for the most part nonparametric. There is nothing on existence of global extrema, on multiple integral problems or on numerical methods but there is much valuable background for the last. Those topics that the author has chosen are treated in depth and detail. The exposition is largely self-contained and, in view of the introductory chapter and a full treatment of classical fixed endpoint problems in Chapter 2, does not assume previous acquaintance with the calculus of variations. However, it will be read with more ease and appreciation by those who have some prior knowledge.

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95[P, X].—C. T. LEONDES, Editor, *Advances in Control Systems, Vol.* 3, Academic Press, New York, 1966, x + 346 pp., 24 cm. Price $14.50.

[P, X].—C. T. LEONDES, Editor, *Advances in Control Systems, Vol.* 4, Academic Press, New York, 1966, xiv + 320 pp., 24 cm. Price $14.50.

As the first two volumes in this series were, the present two are collections of papers which aim to acquaint the reader with recent work in the theory of control systems and its applications.

Volume 3 consists of six articles. The first, by Thomas L. Gunckel, II, entitled "Guidance and Control of Reentry and Aerospace Vehicles" reviews the problems of near-earth navigation and orbit determination, rendezvous guidance and control, and reentry guidance in relation to computer technology and, in particular, the requirements of an on-board computer. The second paper, "Two-Point Boundary-Value-Problem Techniques," by P. Kenneth and R. Mc Gill discusses in detail the numerical solution of two-point boundary value problems for systems of nonlinear ordinary differential equations by the generalized Newton-Raphson algo-

rithm. The third article, "The Existence Theory of Optimal Control Systems," by W. W. Schmaedeke gives a fairly elementary exposition of some of the principal existence theorems, in the usual mathematical setting, for linear as well as nonlinear control systems. The fourth paper, by James M. Swiger, entitled "Application of the Theory of Minimum-Normed Operators to Optimum-Control-System Problems," presents a treatment of various typical control problems in the setting of the moment problem of Akhieser and Krein. The fifth paper, "Kalman Filtering Techniques," by H. W. Sorensen discusses the linear estimation theory as developed by Kalman and others, mainly in terms of a time-discrete model. The last paper, by Stanley F. Schmidt, entitled "Application of State-Space Methods to Navigation Problems," uses the navigation problem as an example to demonstrate the usefulness of various simple mathematical concepts and techniques.

Volume 4 also contains six contributions. The first, by David Isaacs, on "Algorithms for Sequential Optimization of Control Systems" reviews various methods for the numerical solution of the optimal control problem and reports on some computational experiments with them. The second paper, "Stability of Stochastic Dynamical Systems," by Harold J. Kushner gives a brief thoroughly mathematical introduction to Lyapunov's second method as it applies to stochastic stability. The third paper, by Richard E. Kopp and H. Gardner Moyer, entitled "Trajectory Optimization Techniques," discusses the computational solution of optimization problems by indirect methods, gradient methods, the second variation and the generalized Newton-Raphson method, and lists some of their relative advantages and disadvantages. The fourth article, "Optimum Control of Multidimensional and Multilevel Systems," by R. Kulikowski, is concerned with the reduction of complex optimization problems to problems of second- and higher-level control by using for first-level control the known results of standard optimum-control theory. The last two papers are both by Donald E. Johansen. In "Optimal Control of Linear Stochastic Systems with Complexity Constraints" he gives a detailed treatment of a linear stochastic system when the estimator is not of the same order as the process being controlled. In "Convergence Properties of the Method of Gradients" he obtains qualitative results using a large amplitude theory for deviations of the control from the optimal solution and quantitative results in the asymptotic region of small perturbation.

Though the level of presentation varies a great deal and requires different degrees of mathematical and engineering sophistication, these collections should nonetheless be of some use to the informed reader interested in particular aspects of control problems.

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96[P, X, Z].—MOSHE F. RUBINSTEIN, *Matrix Computer Analysis of Structures*, Prentice-Hall, Inc., Englewood Cliffs, N. J., 1966, xiv + 402 pp., 24 cm. Price $12.95.

This text is intended for use in a one-semester senior course or beginning graduate course. As the title of the book would indicate, the intention of the author is not to develop the classical methods of structural analysis, but rather to emphasize