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Book Reviews

R. Cristescu and G. Marinescu, **Applications of the theory of distributions,** John Wiley & Sons Ltd., London, 1973, 225 pp, price £3.75.

The book is intended for applied mathematicians, physicists and engineers. It provides a rigorous introduction to the theory of (vector-valued) distributions and its applications.

The general theory is built up using the concept of "vector spaces with convergence", therefore no knowledge of topological vector spaces is needed. The treatise is largely self-contained, only some results from integration and Banach space theory are given without proof.

After the general theory there are five chapters with interesting applications in the following fields: ordinary and partial differential equations, physics, probability theory and linear dynamic systems.

The reader should be on his guard because there are a lot of very confusing misprints in the text. For example the exponents in the Paley-Wiener estimates on p. 88 are negative, on page 182 a random variable is used as the argument of a test function. Another disadvantage is that many references are to Russian and Romanian text books. There is no index.

Nevertheless I believe that every student in the disciplines mentioned above should read this very instructive book.

J. de Graaf

P. Eykhoff, **System identification: parameter and state estimation,** Wiley/Interscience, London, 1974, xx+555 pp., price £12.50.

System identification is the problem of finding a mathematical model for a system. Thus defined the problem appears to be perhaps the most central question in the physical sciences since obtaining mathematical models is typically the culmination and the goal of much of physics, chemistry, and certain parts of biology. It also is a central problem in economics and some of the social sciences.

In system theory and control engineering, however, one usually considers a much more limited situation in which one has a system with inputs and outputs which can be measured only in the presence of noise and the question is to derive a mathematical model for this system which will match the input/output behaviour of the system optimally, in the sense of some prespecified performance criterion.

This method is, in a sense, a black-box approach since little a priori or axiomatic knowledge is assumed. One thus develops methods which are in principle valid for any system, and in practice this procedure of fitting models to data is very frequently employed in engineering technology and in econometric modeling. In the book under review the author considers state estimation to be part of system identification. This is not customary. The question of state estimation is (at least for linear systems) often a much easier one than the parameter estimation. However, the emphasis of the book is, and rightly so, on parameter estimation.

The book contains two introductory chapters which describe the problem, the philosophy, and indicate some of the areas of application. After that the author discusses some background material on dynamical systems, signals, and probability theory. The next chapters consider parameter estimation which is developed first for discrete time systems and then for continuous time systems. The parameter estimation procedures are divided into two classes: one class of methods are called *explicit* methods in which one uses the data to obtain estimates. It is thus a "one-shot" procedure; the other class of methods are called *implicit* or *model-adjustment* techniques where the data is used to adjust the parameters in a reference model. The idea here is to develop real-time, on-line, recursive algorithms for identification. After a chapter on test signals and one an Bayes' and Maximum Likelihood estimation, the author turns to Kalman filtering and a brief discussion on combined state and parameter estimation (adaptive control). A survey of some applications of systems identification ends the exposition. Most of the discussion is, quite appropriately, concerned with linear systems although nonlinear systems are given more than passing attention.

The book has, as its strong features, that it gives a broad picture, is self-contained, and very detailed in its coverage. It requires essentially no mathematical background and all of the required mathematical machinery is developed in the text. There are numerous references: the list may very well contain essentially every paper written in this area up to about 1970. The algorithms are carefully explained and illustrated by detailed, computer simulated, explicit examples. The book is applications oriented and for the practioner it could be a valuable aid.

The book is less satisfying from a theoretical point of view. It contains many claims but few proofs, it explains many iterative algorithms but has little discussion on their convergence, it pays little attention to spelling out the assumptions or conditions under which its claims are valid, and it introduces many concepts without giving a precise definition of what they mean (although usually a reference is provided). This may in itself not be a serious drawback but the reader ought to be cautioned that many statements may thus turns out to be somewhat confusing. Furthermore the style of the book seems to adhere to a not uncommon belief that vague statements are "easier" to grasp and more intuitive than mathematically precise statements.

Let us consider some examples:

- the discussion in Section 3.2 on orthogonal functions;
- the claim on p. 109 that controllability implies that there exists a *unique* control which achieves the transfer;
- that controllability and observability can be achieved in n-steps. (Although this is correct it must be puzzling and confusing to the uninitiated reader why this is so, and it could be very simply justified by the Cayley-Hamilton theorem);
- the section of canonial forms contains the claim that "since the system is controllable and observable there is at least one non-zero element in each row of the B matrix and in each column of the C matrix";
- the section on discrete Kalman filtering does not mention that the input and observation noise must be white noise processes.

In addition, there is some material which is in our opinion relevant to the material of the book but which is given little or no coverage. Among these is the so-called state space realization theory à la Kalman-Ho and others. Moreover, it strikes one as somewhat odd that a book which has "State Estimation" in its title spends less than half a page on the continuous time Kalman filter and does not discuss the infinite time Kalman filter at all.

System Identification: Parameter and State Estimation will be useful to those who run into a straightforward application or who want a general survey and flavor of the field. However, the intricacies of this complex and fascinating subject will occupy theoreticians for a long time to come. Without doubt system identification is one of the areas of (linear) system theory which is least understood but for which some important progress has been made in the present decade. Because of the care with which it was put together and because of the author's experience in the field, the book by Professor Eykhoff will be a valuable contribution to the development of this field.

J. C. Willems

M. H. Mickle and T.W. Sze, **Optimization in systems engineering.** Intertext Publishing Ltd., England, 1973, 312 pp., price £ 6.50.

This little book is meant as an introductory course in optimization. The authors have collected a number of problems with some theory connected with the problems. Since they have concentrated themselves on solving problems and not on the theory, the latter subject is therefore less extensively treated. Many proofs are not given or in a heuristic way. Many times for a proof a reference has been made to other books. A different name for this book might be therefore: *Optimization Calculus Used in Systems Engineering.*

Still the book has been written very understandingly. The methods are very well explained. The steps are taken very carefully, so that the problems ending each chapter can be solved. The problems are in general highly intrigueing and not too difficult.

The topics dealt within 10 chapters are:

– Topics in analysis and some theorems about algebra, Linear simultaneous equations, Nonlinear algebraic equations, Analytic optimization, Search methods, Linear simultaneous inequalities, Linear programming, Dynamic programming, Selected topics in optimization, Finite-state systems. As can be noticed, the subjects are closely related to systems theory. The authors indicate the level of the book as senior or beginning graduate. I think the student will use this book with pleasure and he might be inspired to do more work and studies in this field, since so many fine examples are offered.

F. G. Beiboer

K.O. Friedrichs. **Spectral theory of operators in Hilbert space**, Applied Mathematical Sciences Volume 9, Springer Verlag, Berlin-Heidelberg-New York, 1973. IX + 244 pp., price DM 14,50, US$ 6,50.

The book provides an elementary introduction to the spectral analysis of self-adjoint operators within the frame work of Hilbert space theory. The guiding notion in this approach is that of spectral representation. At the same time the notion of function of an operator is emphasized.

My impression is that the book is written for those physicists and applied methematicians who have no prior knowledge of modern "abstract" analysis. Even the notion of the Lebesgue-Stieltjes integral is not a preliminary for this book. Instead of using the Lebesgue integral the author introduces pre-Hilbert spaces of square-Riemann-integrable piecewise continuous functions, then the abstract completion to a Hilbert space is carried out. The thus obtained notion of "ideal function" turns out to be sufficiently strong for the development of a spectral theory for self-adjoint operators. The subsequent chapters deal with the theory of bounded, normal, unitary, hermitean operators, a functional calculus and a spectral decomposition of hermitean operators. Then the notion of unbounded, closed operators enters and a spectral resolution of self-adjoint operators is given.

The reviewer does not understand why these lecture notes are re-edited. With the exception of the last chapter (on perturbation of spectra) almost the whole content of this book can be found in at least a dozen of elementary books on operators in Hilbert space.

J. de Graaf

H. J. Stetter, **Analysis of discretization methods for ordinary differential equations**. Springer Tracts in Natural Philosophy, Vol. 23. Springer Verlag, Berlin-Heidelberg-New York, 1973. xvi + 388 pages, price DM 120,—, U.S. $44,40.

This book gives an analysis of discretization methods for initial-value problems of ordinary differential equations. In particular the emphasis lies on stability, on the asymptotic expansion of the discretization error and on error analysis in general. It does not deal with the practical aspects of solving differential equations numerically.

After a first chapter in which general discretization methods are considered, the other chapters deal with: forward step methods, Runge- Kutta methods, linear multistep methods, multistage multistep methods and a final chapter on other discretization methods for initial-value problems. Nordsieck's method falls within this last chapter as well as the extrapolation method of Gragg-Bulirsch-Stoer.

There is not yet a refined theory for stiff systems of equations available but the author hopes that this theory of strong exponential stability might turn out to be a possible basis for such a theory.

For those interested in the fundamental side of numerical analysis this book will be a valuable addition to their library.

A. I. van de Vooren

Forthcoming papers

The following papers have been accepted for publication and will appear in the Journal of Engineering Mathematics:

1. Theory of propagation of cracks, by S. M. Sharfuddin.
2. Longitudinal surface curvature effect in magnetohydrodynamics, by N. G. Bodas and B. K. Gupta.
3. An isothermal theory of anisotropic rods, by M. C. Dökmeci.
4. Eigenvalues of a slightly stiff pendulum with a small bob, by W. D. Lakin.
5. On the radiation of short surface waves by a heaving circular cylinder, by G. Alker.
6. One-dimensional wave propagation and Fokker-Planck's equation, by E. Ghandour.
7. Saint-Venant's problem for inhomogeneous and anisotropic solids, by D. Iesan.
8. Incompressible viscous flow near the leading edge of a flat plate admitting slip, by A. I. van de Vooren and A. E. P. Veldman.
9. Some aspects of non-uniform convergence in an elliptic singular perturbation problem, by O. Diekmann.
10. Structure of contact region for non-symmetric initial disturbances, by L. Halabisky.
11. A variational approach to an unsymmetrical water wave scattering problem, by C. A. N. Morris.
12. Plastic-elastic torsion, optimal stopping and free boundaries, by J. W. Cohen.
13. Large-time inversion of certain Laplace transforms in dissipative wave propagation, by M. L. Rasmussen.
14. On non symmetric vibration of deep spherical sandwich sheels, by S. Mirza and A. V. Singh.
15. Analysis of parameter changes in chemical systems via geometric programming, by J. J. Dinkel and R. Lakshanan.
16. Application of the finite element method with sectional linearization to flow problems, by D. H. Keuning.