Book Reviews

Digital Control of Dynamic Systems—Gene F. Franklin and J. David Powell (Reading, MA: Addison-Wesley, 1980, 335 pp.). *Reviewed by Brian D. O. Anderson.*

The title of the book is accurate. It is concerned much more with digital control than digital signal processing, and to this extent, has but limited overlap with the central concerns of the IEEE TRANSACTIONS ON ACOUSTICS, SPEECH, AND SIGNAL PROCESSING. To be sure, there is some elementary material on z-transforms, on digital filter equivalences to continuous-time filters, and a brief discussion of quantization and sample rate selection, but the rest of the book is fairly and squarely control systems material, and even that material which is not specifically of a control nature is flavored with overtones and examples drawn from control engineering. This is, of course, not meant as a criticism: the authors have in no way misrepresented the subject matter of the book in choosing a title.

The book's preface opens with an assertion that it is "about the use of digital computers in the real-time control of dynamic systems such as servomechanisms, chemical processes, and vehicles which move over water, land, air, or space." What this means is that the book has as its central concern the analysis and design of sampled-data control systems, from which it branches out to discuss various specialized themes. Illustrations are taken from the applications areas mentioned. Other than in its mention of quantization and sampling rate problems, there is no significant discussion of the detailed computer-related problems of, for example, interfacing, choice of programming language, and the like.

The preface also asserts that the book is in effect pitched at students who have had something like a first course in control systems, with some knowledge of matrix algebra but no previous acquaintance with state-space ideas. In the reviewer's experience as an instructor of a course using the book as text, this is accurate, save that one could add that prior exposure of students to state variable ideas would be of great help. Apart from the question of background knowledge, the general level of maturity which the book calls for from students is about that which a senior should have. The book is well organized, discussions are clear, important points are carefully highlighted, consistent notation has been used throughout, great care has been taken with examples, and there are good collections of problems for each chapter. The authors have also resisted the temptation to include the more baroque details of many aspects of the subject, and have gone to some care to locate helpful reference material (various transforms, matrix theory and notions of probability and stochastic processes) in an Appendix. All this means that students find the book very attractive to use. Because it is also up to date, and because of the subject matter covered (described below), this reviewer as an instructor using the book also found it very attractive, and certainly outranking other competitors.

After an introductory chapter, the book considers the z-transform description of sampled-data systems, and several approaches to finding discrete equivalents to continuous transfer functions, the latter being most carefully done. Next, the book describes the analysis of sampled data systems, followed by the design of controllers for such systems. Classical control approaches are used to this point; the discussion is comprehensive, and makes good contact with continuous time ideas which students should have experienced earlier. One could perhaps quibble at the very small degree of attention paid to the constraints of controller bandwidth and power, and the extent to which high-frequency uncertainty in the plant limits the designer's ability to suppress the effects of plant parameter variation or nonlinearities by high gain. State-space approaches to design occupy the next chapter. At this level, controllability and observability deserve to be located at the end rather than beginning of the chapter, and this is what the authors have chosen to do.

Two further chapters contain important material on quantization and sample rate selection. The latter particularly is given with a highly control flavor, considering as it does issues of disturbance rejection and sensitivity to plant parameter variation.

Finally, the book has two chapters which introduce the student to two more advanced topics: system identification, a topic of increasing relevance given the ability to hook a computer onto a system, and multivariable and optimal control. The latter chapter develops the earlier state-variable ideas. Somewhat strangely, these chapters are interpolated between the two chapters on quantization and sample rate selection. Topics *not* dealt with in the book (and this will probably disappoint some instructors) include minimum variance and self-tuning regulators.

The combination of what is really superlative writing technique, in the broadest sense in which these words can be applied to a text book, and the wise choice of subject matter will guarantee this book a most favorable reception. But readers of the TRANSACTIONS are again warned: it is a textbook on digital control, not digital signal processing.

Brian D. O. Anderson (S'62-M'66-SM'74-F'75) was born in Sydney, Australia, in 1941. He received the B.S. degrees in pure mathematics and electrical engineering from the University of Sydney, Sydney, Australia, and the Ph.D. degree in electrical engineering from Stanford University, Stanford CA.

Before joining the University of Newcastle in 1967, where he is a Professor in the Department of Electrical Engineering, he was a faculty member of the Department of Electrical Engineering at Stanford University and staff consultant at Vidar Corporation, Mountain View, CA. He has also held appointments as a Visiting Professor at Southern Methodist University, University of Massachusetts, University of California at Berkeley, and Stanford University. He was Head of the Department of Electrical Engineering at the University of Newcastle from 1967 to 1975. He is coauthor of five books, *Linear Optimal Control*, *Network Analysis and Synthesis*, *Foundation of Systems Theory*, and most recently *Singular Optimal Control*, with D. J. Clements, and *Optimal Filtering*, with J. B. Moore. His research interests are in control, communication systems, and networks, and he has written many papers in these areas. From 1971 to 1977, he was a member of the Australian Research Grants Committee and since 1977 has been a member of the Australian Science and Technology Council.

Dr. Anderson is a Fellow of the Australian Academy of Science and Institution of Engineers, Australia, and a member of Sigma Xi, SIAM, and Eta Kappa Nu.

Array Processing: Applications to Radar—S. Haykin, Ed. (Stroudsburg, PA: Dowden, Hutchinson and Ross, 1980, 362 pp., $32.00). *Reviewed by William S. Hodgkiss.*

This is volume 22 in the Benchmark Papers in Electrical Engineering and Computer Science series. It is divided into two parts. Part I contains eight papers on scanning modulation