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book reviews

NONLINEAR SYSTEMS ANALYSIS,

M. Vidyasagar, Prentice-Hall, Inc., 1978, 302 pp.

REVIEWED BY S. H. JOHNSON[1]

The author intends that this book be used at the senior and/or first year graduate level to teach the systems approach to engineers and applied mathematicians. It is difficult for a small book to adequately fill such needs unless one assumes that the graduate students do not have any "systems" background. At the senior level the students may well find the notation to be unfamiliar. However, most concepts are simply stated and portrayed in their simplest form. The explanations are usually quite good. The major shortcoming as an undergraduate text is the total concentration on the analysis of mathematical systems with no discussion of the techniques of obtaining such systems from physical situations. From the graduate students viewpoint the major shortcoming is the shallowness of the treatment of important techniques. The treatment of the asymptotic method of Krylov and Boguliubov is an example. Only the first approximation for autonomous systems is discussed with no indication of the variety of problems that can be attacked nor the use of higher approximations. Only the case in which the auxiliary equations decouple is presented and Van der Pol's equation is used as an example. This is simply too scant a treatment to be of any use to graduate students. If used to explain "resonance jump" or some other characteristic of weakly nonlinear systems which is outside of the students' experience in linear vibrations it could be valuable. As presented it is of little use to graduates or undergraduates.

The book emphasizes the development of formal mathematical skills rather than insight into the practical utility of the techniques described. The treatment of describing functions is an example. The entire development is mathematical. The use of the first Fourier component is shown to be a "best" representation of the output of a memoryless nonlinear element without discussion of whether or not it is a good representation. The importance of the linear part of the system being low pass is briefly mentioned in the last paragraph of the describing function section. The describing function is employed without the help of the Nyquist diagram or other frequency response approach. This heightens the feeling that useful "engineering" techniques are being treated in overly mathematical fashion. There is no discussion of the important question of limit cycle stability which is often as important as limit cycle existence.

Eleven pages are occupied with a presentation of numerical solution techniques. First and second order Runge Kutta methods are derived and a fourth order scheme is shown. Other explicit schemes are briefly covered as is the use of implicit schemes with explicit ones in predictor-corrector combinations. However, computational efficiency is given as the forte of multistep methods with no indication of the much more important differences in stability properties.

The third and final solution approximation method is called singular perturbation in the text. The method described is only remotely related to the mathematics usually referred to a singular perturbation theory.

Chapter five, which is equal in length to chapters one through four combined, is devoted to stability determination. The author presents Liapunov's direct method without recourse to figures or geometrical interpretation of Liapunov functions. Then Liapunov's indirect method is obtained from the direct method by linearization. There is a lengthy discussion of the Lur'e problem and the Popov criterion. Familiarity with Nyquist diagrams is assumed. Finally there is a brief discussion of the stability of systems with slowly varying parameters. Rather than extend the previously introduced asymptotic methods of Krylov and Boguliubov to slowly varying systems the author pursues a new approach in which the stability of a family of associated stationary systems is investigated.

The final chapter is devoted to input/output stability and demonstrates more than any other the urge to mathematical elegance, some might say mathematical overkill, which qualifies this book as a foundation for further work but makes it unsuitable as the text in a terminal course in systems/controls.

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NUMERICAL METHODS IN FLUID DYNAMICS,

Maurice Holt, Springer-Verlag, 1977, 253 pp.

REVIEWED BY A. K. MACPHERSON[1]

The structure of the book is systematic and has obviously been tested in the classroom. Each section, usually a new chapter, starts with a description of the mathematical foundations of a numerical scheme, this is followed by a description of the details of the numerical analysis and finally one or more examples of the application to problems. The limitations of each technique are given and the stability of the schemes are discussed where possible. An appealing feature of the book is the inclusion of computer listings for a number of sample problems. This book would be quite well received by graduate students where the book is used as the basic text. The inclusion of various techniques of rather recent vintage is a useful incorporation and generally this book appears to avoid reproducing much of the conventional material found in books on numerical analysis. This can be seen just from the chapter headings which are Godunov Schemes, BVLR Method, Method of Characteristics for Three-Dimensional Problems in Gas Dynamics, Method of Integral Relations, Telerin's Method and the Method of Lines.

The introduction states "the course was originally presented as the last of a three quarter sequence on compressible flow"

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