
REVIEWED BY ROBERT W. KOLKKA1

The text *Mathematical Models* is the result of the author's construction of a first course in applied mathematics at Rutgers University. Mechanical vibrations, population dynamics, and traffic flow were chosen to illustrate the application of mathematics. The treatment of each area is entirely self-contained, and requires no previous exposure to any of the physical content of the material. A knowledge of a standard calculus sequence and ordinary differential equations is presupposed, but certain critical aspects are reviewed. In each of the three areas the major emphasis is on the nonlinear aspects of the phenomena.

The treatment of mechanical vibrations is basically that which can be found in the first few chapters of any standard "physics" text on classical mechanics.2 Newton's laws are presented in the usual manner with the common misconception that the law of momentum of momentum is a subsidiary derived principle, arising from the rate of change of linear momentum coupled with the existence of pairwise equilibriated forces (prob. 14.4 in text). The spring-mass systems and pendulum problems are presented in full enlightening detail, much more so than in any standard text on the subject. The nonlinear systems are emphasized and analyzed by phase plane methods. The phase plane method presented differs from the standard treatments in that it is complete. Important points such as, for example, distinguishing between isolines and solution curves, are well clarified. In my opinion, as one who studies rational mechanics (yes, classical mechanics is still alive, well, and living at Lehigh University), the treatment of the pendulum problem is excellent. Comparison (of the phase plane methods) to other methods such as the "Liapunov direct method," etc. are unfortunately omitted, perhaps due to level of presentation and the author's orientation as an "applied mathematician."

The mathematical models presented in the section on population dynamics are crude (for those Biologists interested in the text), but they have to be as such, as the author explains in substantial detail. Discrete models are presented, in light of which sections on solving constant coefficient difference equations, both first and second order are set forth in a very straightforward fashion. Continuous models are also used, both density dependent and logistic. Mutualism, competition, and predator-prey models are analyzed in the phase plane in much the same manner as were mechanical systems. The stability analysis presented in this section is quite good, points such as the destabilizing influence of time lags are illustrated.

The approach to traffic flow is that of the continuous one-dimensional model which is contained in a book by G. B. Whitham.3 The treatment here is presented in great detail (135 pages as opposed to 12 pages in Whitham's book), as an example, the author consumes sixteen pages to develop $(\partial p/\partial t) + \partial/\partial x (p u) = 0$, where $p$ is of course, the density and $u$ the velocity field. Functional relations between the velocity field and density field proposed, and compared with actual data from the Merrit Parkway and Lincoln Tunnel. Steady state car following models are discussed. The most important part, in view of engineering science is that the equation, $(\partial p/\partial t) + C(p)(\partial p/\partial x) = 0$, is discussed in total entirety; linearization and the consequences thereof are examined. The method of characteristics is examined thoroughly, with a detailed discussion of shocks. Inclusion of problems, such as; after a traffic light turns green, uniform traffic stopped by a red light, and effect of traffic being stopped momentarily, helps elucidate matters.

The overall presentation is greatly enhanced by the inclusion of inumerable figures and illustrations throughout the book. The book serves its purpose well, and it should be noted that although the techniques are developed in light of the chosen topics, they apply to many facets of engineering science. Systems analysis in population dynamics is exactly the same as it is in engineering controls, and traffic flow serves as an excellent introduction to gas dynamics.

AUTOMATIC CONTROL SYSTEMS, by Richard M. Phelan.

REVIEWED BY S. H. JOHNSON4

The books reviewed for this *Journal* are usually in print and some have been for years. In this case a publisher has provided the journal with a galley proof copy of a yet-to-be-released textbook on classical control system design. The book review process does not readily accommodate either such a document or the publishers hope that a review will promptly appear in the journal. There are two difficulties. The only compensation granted the reviewer is the copy of the book reviewed. A proof copy is considerably less compensatory than the final hardbound volume. Reviewers are usually slow as is the entire process. It is not uncommon for a year to elapse from reviewers receipt of a book to publication of a review. There is also a shortcoming from the reader's point of view: from a proof copy, no judgments can be made concerning appearance, paper and printing quality, or physical construction. The most noteworthy attribute of one recently reviewed book was that its pages fell out after modest use. The above notwithstanding, a review follows.

This book is described by the publisher as being, "a revolu-

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1Graduate Student, Lehigh University, Dept. of M.E.-Mech., Bethlehem, Pa.
4Associate Professor of Mechanical Engineering and Mechanics, Lehigh University, Bethlehem, Penn.
tionary, practical approach for students, teachers, and engineers." It does present a practical approach to the solution of single input-single output feedback problems. This does not particularly recommend the book as an undergraduate text since one is usually trying to accomplish considerably more than that in such a class. This ad hoc practical approach is divorced from the context of general dynamical systems. The revolutionary aspect is not revolutionary at all. Classical control theory can be described as being a collection of methods for establishing the behavior of systems without solving the differential equations of motion. If you agree that direct solution of the system equations of motion is a practical method of investigating control system designs then you will probably agree with Phelan that classical control theory is sophistry.

The author emphasizes the importance of final control element saturation. This point is certainly overlooked in most texts. Not only do texts on linear theory omit mathematical consideration of hard limits, they fail to warn the fledgling designer to check the magnitudes of intermediate variables during typical transients. The author overstates the importance of another warning: namely, the need to prevent reset-windup, but that is less of a sin than to omit mention of it in an avowedly practical book. Texts which deal with such topics usually apply describing functions to extend linear methods to accommodate these simple nonlinearities.


REVIEWED BY DONALD ROCKWELL

In recent years, great strides have been made in the field of laser doppler anemometry (LDA), attracting an increasing number of fluid mechanics researchers. Some have been lured by the unique capabilities of this method of flow measurement, only to discover that considerable expertise is needed to sidestep fallacies arising from lack of understanding of the optics and electronics of the complete measuring system. Consequently, it would seem that the most suitable sort of book on this subject would have to incorporate survey articles to orient the novice, some specialized papers to aid those already involved in measurements, and a selection of papers describing a variety of actual LDA setups. From the perspective of this reviewer (a novice in the field of LDA), all of these objectives have been achieved.

The reader will find the survey articles of F. Durat (who was involved in contributing five papers to this book) on electronic processing of optical anemometer signals and of W. K. George, Jr. on accuracy limitations inherent in the laser doppler signal to be so well written that little, if any, prior experience with LDA is necessary for easy comprehension of the material. Newcomers to LDA will find the paper of F. Durat and W. H. Stevenson on the use of Moire patterns for visually modelling laser doppler signals to be particularly helpful. A number of more specialized, but equally worthy, papers treat topics such as velocity biasing, particle concentration effects, noise effects, and various means of processing the laser doppler signal. Measurement of liquid-gas two phase flow is treated in several papers. Finally, a selection of twenty-two applications of LDA provides the reader with a series of diverse case studies that will make his own experiment more solidly based. It would be hard to imagine any worker in the field of LDA not having access to this work.


REVIEWED BY DONALD ROCKWELL

The need for a comprehensive book on unsteady flow measurement will not be disputed by workers in fluid mechanics, who have recently witnessed both the appearance of increasingly sophisticated experimental techniques and the change in perspective of studying unsteady turbulent flows from a "random" to "organized" viewpoint.

This book contains a collection of diverse articles of varying depth and quality. Near the beginning of the text an attempt was made to write an introduction to the theory of unsteady flows in a space of nine pages. Success in such an endeavor requires concentrated description of theoretical concepts coupled with extensive references. Instead, no such references are offered, and the reader is confronted with the paragraph "One sometimes hears about the stability of unsteady flows, but it is not easy to define such a concept without a rigorous mathematical formulation". Pity the novice who interprets this as a passing rumor. (Stability of perturbed turbulent flows has been studied by Hussain and Reynolds and Schachenmann and Rockwell.)

In subsequent chapters, the following measurement topics are well treated: unsteady pressures, forces, and accelerations; heat transfer, skin friction, total temperature, and concentration; gas density; and combustion parameters. Velocity measurement techniques of hot wire (and hot film) anemometry and laser anemometry are described in separate chapters. Not only does G. Comte-Bellot provide an extensive review of the former anemometry technique, but also briefly compares it with the latter technique.

The experimentalist will also greatly benefit from chapters on analog and digital storage and display systems, implementation of digital systems for signal analysis, space-time correlations, and conditional sampling.

On the whole, this book will be of considerable value to both newcomers and to active workers in this area who would like to justify the accuracy of their technique, or to use the detailed bibliographies to help them select an alternate technique.

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1Professor of Mechanical Engineering, Department of Mechanical Engineering and Mechanics, Lehigh University, Bethlehem, Pa.


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