Book Reviews

Parametric Random Vibration, by R. A. Ibrahim, John Wiley & Sons, Inc., New York, 1985, 342 pp., $59.95.

There have been a number of books devoted to the topics of random vibrations [e.g., Crandall and Mark (1963), Bolotin (1984), Dimentberg (1980, in Russian), Lin (1967), Robson (1963), Soong (1973)] and stability of stochastic systems [see e.g., Lecture Notes in Math, No. 294, R. Curtain, ed. (1972), Khazminskii (1980, Sijthoffand and Noordhoff), Kushner (1967, Academic)]. The first group of books have been concerned to a great extent with the problems of vibrations of linear and non-linear mechanical systems subjected to random forcing functions. Randomly fluctuating parameters, although treated, were not central to the theme of these books. The second group of books directed attention to the asymptotic properties of the solutions of stochastic differential equations with randomly varying coefficients. They are somewhat more mathematical and are not directly motivated by problems of random vibrations.

On the other hand, the text under review appears to be the first that is devoted exclusively to the study of vibrations of linear and non-linear systems with randomly varying coefficients. It treats all aspects of the general problem of the response of such systems and their importance in the subject of random vibrations. It is written in the style of a descriptive monograph, with many examples illustrating the concepts developed, and contains no excercises. In Chapter 1, the author formulates, describes, and discusses the class of problems treated. In the remaining eight chapters that comprise this book, the author presents the basic concepts and techniques that are central to the analysis of these stochastic systems.

He illustrates through applications those properties of the response statistics that can be obtained exactly or, as is more often the case, approximately. The response statistics that are naturally of interest are joint probability densities, moments, and their evolution as functions of time. Asymptotic sample response properties such as stability are also treated. The techniques and tools that bear upon the study of these statistical properties such as hierarchy problems, closure methods, linearization techniques, Fokker-Planck methods for the Markov case, Ito equation formulation (white noise coefficient case), Ito calculus, Stratonovich formulation (physical noise coefficient case), and Wang-Zakai correction terms, are all described and discussed.

The author, who is basically an engineer motivated by engineering problems, presents his subject in a way that will be understood by engineers. But it must be kept in mind that although this book does not contain complicated mathematical proofs of the concepts described and applied, the subject that the text is devoted to does require a sound background in probability and probabilistic methods in order to understand the material.

Chapters 2–4 contain the underlying probabilistic concepts required. The author concentrates on systems with wideband physical coefficient fluctuations, as well as Gaussian white noise coefficient fluctuations. Thus, there is a great deal of description of Ito equation models with the associated Fokker-Planck equations. This is motivated by the fact that most of the tools available for study of response statistics of systems with randomly varying parameters is for this class of problems, i.e., for systems with Gaussian white noise coefficients. In this context the author discusses the ideas that relate structural systems with wideband coefficients (physical white noise) to the associated Ito equations. This necessitates his inclusion of definition and comparison of the Stratonovich integral with the Ito integral.

Furthermore, the asymptotics that relate systems with small parameters and physical noise coefficients to the associated Fokker-Planck equations (as the small parameters approach zero) via the Khazminskii-Stratonovich-Papanicolaou (KSP) theorem are also stated and applied in the text. The author never loses sight of the fact that his problem is random vibrations of mechanical and fluid systems. Hence, his illustrations and examples involve the response of columns with longitudinal excitations, helicopter blades, free liquid surfaces under vertical excitations, panel flutter, and pendulums with vertical base excitations. These specific examples are presented showing how the various probabilistic methods can be brought to bear upon the particular application. The last of the nine chapters is devoted to a comparison of experimental results with the results based upon analysis (exact or approximate) obtained from probabilistic methods.

The author describes a subject that has developed essentially over the past 25 years. The subject has become somewhat mature, although it is still undergoing development. He has attempted to give a comprehensive description and idea of its evolution, and has been quite careful in giving credit to those who have helped develop the overall subject. Each chapter contains a reasonably well-documented history with the pertinent references.

Thus, the non-specialist can obtain an excellent idea of how the subject has grown as well as what papers have been central in this growth. Indeed, the bibliography comprises forty pages! This alone gives an idea of how extensively the author has sought to present the subject.

It is a very readable book. However, the book describes but does not assess relative importance. Furthermore, the author does not suggest new problems to be looked at, or where the subject is going. Perhaps this is asking too much. On the negative side, better explanations of a few conceptual ideas, such as a clearer discussion of the weak convergence property of the KSP theorem, would have been helpful. Also, there are a number of typographical errors, which the astute reader will certainly pick up.

Finally, having been associated with this topic over the years, this reviewer feels that this book is an excellent description of the subject and is most certainly a valuable addition to the literature on random vibrations. It is a useful reference for those who are familiar with the subject, and a good source of ideas and results for those who wish to learn about the subject.

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Incompressible Flow, by Ronald L. Panton, John Wiley & Sons, Inc., New York, 1984, 780 pp., $47.95.

The text by Ronald Panton of the University of Texas at Austin is an excellent addition to the literature on fluid mechanics and one which will be appreciated by first-year graduate students interested in the subject. Although the main audience is expected to be first-year graduate students in mechanical and/or aerospace engineering departments, the book is fundamental enough to serve as an introduction to students of all disciplines. The selection of material is broad, with many applications which strongly reflect the author's expertise and research experience in the area. However, many professors and researchers in traditional mechanical and/or aerospace departments may be disappointed by the lack of material on turbulent flows and convective heat transfer. The text is strong in its presentation of the fundamentals of fluid mechanics and I feel that it will be widely considered in the future as one of the better introductory texts in the field.

In general, the basic material is arranged in logical order, starting with careful definitions from continuum mechanics and thermodynamics, proceeding to mathematical preliminaries, and then to a thorough and well thought out derivation of the Navier-Stokes equations. All of the presentations are well described and there are ample geometric and physical arguments utilized. The clarity of the arguments are among the best that the present reviewer has seen, but they do suffer from a certain dryness due to a lack of physical examples. If the author had woven some experimental data and flow visualization results into his introductory chapters, the material would be outstanding.

The choice of the individual sections illustrating the various Reynolds number regimes and approximations is exemplary and each section is essentially self-contained. This is indeed fortunate since it is easy to choose the material in a different order than that given in the text. Many traditional subjects such as low Reynolds number flow and laminar boundary layers (usually given early) are presented near the end of the textbook, but this should not deter some of the more traditional academics from the selection of this text. The sections on boundary layers, inviscid flows, and vorticity dynamics are very well done and represent a new height in clarity and completeness for textbooks at this level.

The presentations of the mathematical preliminaries are very good and carefully done, and help give the textbook a quality of completeness. The author also does an important service by presenting a small but high-quality collection of examples from numerical fluid mechanics. Although these examples do not represent a comprehensive presentation of this growing and important field, it does fill in many of the nonlinear solutions that cannot be found by strictly analytical methods. At the level of the fundamental principles and material presented in this book, computational fluid mechanics can best be used to illustrate flowfield patterns, and to clarify complex behavior beyond the scope of simple descriptions.

The most outstanding characteristic of this textbook is the precise, clear and self-contained regimes into which the author has divided the subject of incompressible viscous flow. From these divisions students will clearly see why researchers and institutes are built around high and low Reynolds numbers flow characteristics and why fluid mechanics can be such a rich and diverse field of study. This richness is at the same time the reason why most textbooks will necessarily be incomplete, and why it is easy for me to mention that this book is deficient on the subjects of turbulent flow and convective heat transfer. The omission of a more complete section on turbulent shear flows is probably the most serious lack, because of the dominant role that turbulence has in most practial applications. However, even with this substantial omission I would strongly recommend that the book be considered as a teaching text and as a book for self study.

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