Applied Structural and Mechanical Vibrations
Theory and Methods, Second Edition
Paolo L. Gatti
CRC Press, Boca Raton, FL USA, (2014),
602 pp., hardbound, 132 USD,
ISBN 978-0-415-56578-3

Before I describe the contents of the book, the binding of this book is called "perfect" but is similar to the binding of cheap, paperback books. The pages are not gathered and sewn into signatures. Instead they are glued together with a thick layer of glue. The paper is good but after extensive use over a period of years, the book will fall apart. This is unfortunate because this is the kind of book that you might like to keep on your shelf as a reference.

When I accepted the book to review, I thought that it was a graduate level textbook. However, there are no problems at the end of each chapter. After I had read a few different parts of the book, I looked at the short biography of the author. The author graduated with a degree in an area of physics and then entered the field of vibration engineering. I have met others who followed the same path and I am one of them. The area of mechanical vibrations, as well as acoustics, is based on analytical mechanics, experimental mechanics, as well the electrical engineering aspects of data acquisition and signal processing and the more artistic area of the display of quantitative information. Anyone working in this field is bound to interact with people who use the particular vocabulary of physics, mathematics, mechanical or electrical engineering. I think this book successfully addresses that problem in a fairly systematic way.

The book consists of roughly four parts: a preliminary introduction (pp. 1–118), SDOF, MDOF and continuous vibration systems (pp. 119–420), experimental modal analysis (pp. 421–476) and random vibrations (pp. 477–584). There are also two appendices: vector and matrix algebra and assessment of vibration intensity. There are 117 references, among which I recognized several helpful texts and handbooks.

The preliminary introduction includes some fundamentals like linearity, what degrees of freedom means, complex notation, beat phenomena, physical description of motion (displacement, velocity and acceleration), idealized mechanical components (mass, spring and dashpot), and analytical mechanics. These fundamental discussions show clearly to an electrical engineer the definitions of mechanical components that are analogs of inductors, capacitors and resistors. There is an introduction to Fourier series and transforms that includes some sophisticated concepts and places them in the field of mechanical vibrations. The chapter on analytical mechanics is thorough and includes Hamiltonian and Lagrangian methods. In some chapters "bra-ket" notation is used while in others, integral and differential notation.

The part on vibrational systems includes a chapter on SDOF systems: the effects of damping and definitions of quantitative descriptions, such as damping ratio, logarithmic decrement, displacement velocity and acceleration resonant frequencies, the effects of damping and equivalent viscous damping, frequency response, shock response and transient response. Approximate methods for estimating the response of a system that is approximated as an SDOF are given, too. The chapter on MDOF contains several cases of increasing complexity before presenting matrix formalism and increasingly more complicated conditions such as proportional and non-proportional damping and the response to excitation. The chapter on continuous systems presents the solutions to several well-known problems: the string, membranes, thin rods and thin circular and rectangular plates. The chapter on MDOF and continuous systems includes the modal approach and the approximate Rayleigh–Ritz method. Numerical examples are given sometimes.

The third part on experimental modal analysis is only one chapter, which used to be three chapters according to the preface to the second edition. In spite of this, I found the chapter to be clearly written and introduced me, who has never performed experimental modal analysis, to the subject. The chapter includes three primary questions to be answered before any experiment is performed: "What do we need to know," "What is the desired outcome," and "After the experiment, what steps are taken and why?" The two main purposes of performing modal analysis are to determine the levels of response of a specific structure or to validate a model of the structure. The chapter does not include electrical issues around recording the data, but does include mechanical considerations, such as the mass of an accelerometer and the mounting of the structure. Specific examples of Bode and Nyquist plots of the receptance, mobility and accelerance are shown with clear explanations of the behavior. While reading about the utility of log–log plots, I remembered being told by a colleague that long ago, one goal of applied scientists was the creation of graph paper that presented any data as a straight line. The chapter does not present specifics about a list of 25 popular methods of parameter estimation but a comprehensive reference is given. From the preliminary information given in the chapter, I felt confident that I could learn any of the methods.

The fourth part consists of two chapters on probability, statistics, stochastic processes and random vibrations. Basic definitions, a few specific distributions,

marginal distributions and random vectors are included, some with more detail than others. There are several references given for a deeper discussion of any topic. The last chapter presents material on stochastic processes. I wish that the author had included a longer discussion of practical considerations of stationarity and ergodicity because these tend to be confusing to many people and data can be taken and analyzed improperly. However, the chapter does describe the properties, including bandwidth, of power spectral densities and the steady-state and transient responses of systems to stationary vibrations. Threshold crossing rate, peak distribution and fatigue damage from random excitation are presented for narrowband random vibrations.

In summary, I found the book to be well written with clear explanations. I found only two typographical errors and I could easily work around them. I think that this book is a good reference book to have on the shelf to refresh your memory about some aspects of vibrations or to find a reference to deepen your understanding. It is also a good book for people – like physicists or electrical engineers – who have a technical background but not in this area of mechanical engineering. In my opinion, there are two deficiencies in this book. First, the book could be more useful if numerical recipes and numerical examples were included in more sections. Solved numerical examples can be useful for developing and using software. Second, a list of all symbols would also be helpful. However, the bottom line is that I am happy that I was given this book to review; I will keep it on my shelf and use it as a handy reference with clearly written verbal, mathematical and graphical descriptions.

Charles F. Gaumond
14809 Reserve Road,
Accokeek MD 20607-9734, USA
charles.f.gaumond.acoustics@gmail.com