Engineering Vibrations, Second Edition
William J. Bottega
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This book is an outgrowth of the author's notes for his engineering vibration courses at Rutgers University. In the Preface to the first edition, the author explains that he perceived a need for a middle ground between two categories of textbooks in this field. On the one hand, some texts were found to "*...emphasize mathematics but generally fall short on physical interpretation and demonstrative examples...*". On the other hand, "*...others emphasize methodology and application but tend to oversimplify the mathematical development and fail to stress the fundamental principles...*".

This comprehensive book probably falls more into the first category than the second. Although the book contains a number of very interesting problems, a 21-year-old undergraduate student of engineering might silently wonder why the material is presented in a way where rigor triumphs over insight.

This book is divided into 14 chapters, the first of which is named, "Preliminaries." This chapter discusses basic concepts including statics and kinematics of particles plus connected discrete elements. The scope of the first chapter is similar to what one might find in a general college physics course. This second chapter covers free vibration and damping mechanisms for single degree-of-freedom dynamic systems. The second chapter is well developed and is liberally sprinkled with a number of interesting example problems.

The third and fourth chapters discuss single degree-of-freedom systems excited with periodic and nonperiodic signals, respectively. The fifth chapter is named, "Operational Methods" and is mainly concerned with Laplace transforms as a simplified means to help solve the linear (ordinary or partial) differential equations of motion.

The sixth chapter addresses the dynamics and damping of multi degree-of-freedom systems. The seventh and eighth chapters explore free and forced vibration of these same multi degree-of-freedom systems.

The eighth chapter introduces the concept of a dynamic system's natural modes and then proceeds to mathematically describe the modal behavior using matrices. This chapter also contains a section on proportional (viscous) damping. The presentation of the material focuses on the phenomenon from a mathematical perspective but is devoid of insight regarding the subtle implications of damping within vibrating systems. Here the student will need to gain a more intuitive understanding of damping by reading Chapter 2 of the classic 1934/1956 book, *Mechanical Vibrations* by Jacob Pieter Den Hartog. Alas, this beautifully written and lucid reference is not cited by Bottega.

The ninth chapter addresses continuous dynamic systems that are not amenable to models having a finite number of connected rigid elements (a beam vibrating transversely is one example of such a distributed system). Three historical mathematical developments of vibrating beam theory are presented in this chapter; it also discusses advances in mathematical treatments beginning with Euler–Bernoulli in the 18th Century, then to Rayleigh in the 19th Century, and finishing with Timoshenko in the 20th.

Unfortunately, the book does not mention the ingenious Rayleigh–Ritz solution for computing the eigenfrequency of (an assumed) beam vibration mode shape (although Bottega does cite Leonard Meirovitch who discusses the Rayleigh–Ritz solution in his book, *Fundamentals of Vibrations*).

The train of these earlier mathematical developments is completed by the so-called "beam-column" mathematical model in which axial loads are imposed on a vibrating beam.

Chapter 10 discusses free vibration in continuous one-dimensional systems such as a suspended cable or a beam that rests on a continuous elastic foundation. Chapter 11 goes on to address forced vibration in these same continuous one-dimensional systems.

Similarly, Chapter 12 deals with the dynamics of two-dimensional continuous systems such as (thin) sheets and (thick) plates. Finally, the free and forced vibrations of these two-dimensional continuous systems are covered in Chapters 13 and 14, respectively.

The cited references in each chapter's bibliography are rather limited. At the end of several chapters, Bottega repeatedly cites Leonard Meirovitch and his three books, *Fundamentals of Vibrations* (2001), *Elements of Vibration Analysis* (1986), and *Analytical Methods in Vibrations* (1967). Another reference cited several times is *Theory of Vibration with Applications* by William T. Thomson. Several other classic books are also listed in various chapter bibliographies including *A Treatise on the Mathematical Theory of Elasticity* by Augustus Edward Hough Love, *Engineering Vibrations and Theory of Plates and Shells* by Stephen Prokopovych Timoshenko et al. plus The *Theory of Sound* by John William Strutt (Lord Rayleigh).

It is reasonable for a reader of such an extensive book to expect a longer list of other references for further study. Unfortunately, the subject book does not contain such a list.

With respect to this list, many authoritative books in the field come to mind. One is the *Shock and Vibration Handbook* edited by Cyril Manton Harris. Others include the collection of mathematical solutions summarized by Arthur W. Leissa in his books, *Vibration of Plates* and *Vibration of Shells* and also by Robert D. Blevins in his book, *Formulas for Natural Frequency and Mode Shape*. Another is the 1994/2001 book by Daniel J. Inman, *Engineering Vibration*. Finally, the fine 1976/1996 book by Andrew Dimarogonas, *Vibration for Engineers* should also be included on the list as it contains unique historical sidebars about the pioneers who advanced the mathematics of mechanical vibration.

In the field of vibration analysis, it is useful to observe many points of view and also gain insight as various experts approach a problem and then go about solving it. I would certainly recommend Bottega's *Engineering Vibrations* as a companion to some of the classical references mentioned above.

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