Book Review

Vibrations and Waves in Physics, Third Edition, by Ian G. Main. Published by Cambridge University Press, New York, 1993. $69.95, 395 pp.

If you do not already possess this gem, buy it! Even if your library already includes a dozen or so books on vibrations and wave propagation, buy it! The insights into the subject that are found in this book, the breadth of coverage, and the concise and precise use of the English language mean that you will gain a better appreciation of vibrations and waves from this tome than from all your other books combined.

I do not make this recommendation lightly. For years I have benefited from Thompson's *Vibration Theory and Applications*, Achenbach's *Wave Propagation in Elastic Solids*, Graff's *Wave Motion in Elastic Solids*, Elmore and Heald's *Physics of Waves*, Towne's *Wave Phenomena*, and, for more esoteric applications dealing with impact and explosive loading, Rinehart's *Stress Transients in Solids* and Kolsky's *Stress Waves in Solids*. All these are excellent books providing thorough coverage of their selected topics. All are well worth reading, which makes Professor Main's accomplishment all the more impressive.

This third edition of the book is intended as an undergraduate text on vibrations and waves. As such, it succeeds brilliantly. Several factors make the book unique. The author writes in clear, readable English; convoluted jargon is left out. The book is self-contained; the student can learn the principles involved simply by reading the text and needs no instructor to decipher the author's intent. The author makes his points in a straightforward manner, no need to read between the lines, and he does it concisely. The material on free vibrations, for example, is covered in half the space required by other texts.

The book leads the student to a thorough understanding of the basic concepts of vibrations and waves, shows how these concepts unify a wide variety of familiar physics, and provides an introduction to advanced topics. Each section of the book ends with a brief summary of its salient contents. Some 180 problems are given with numerical answers provided together with hints for their solution. The new material includes an elementary, descriptive introduction to the ideas behind the new science of chaos.

The first chapter introduces free vibrations with a typical spring-mass example. Thereafter, all similarity with other books on the subject ends. The requisite equations of motion and boundary conditions are developed lucidly and concisely. Almost imperceptibly, the notion that vibration comes about as the result of two opposing properties of the system is introduced. The mass, given an acceleration determined by Newton's second law, will acquire a certain velocity, and a corresponding momentum, by the time it reaches its equilibrium position and so it will overshoot. Now the mass is acted upon by a return force in the opposite direction. It is decelerated, brought to rest, and accelerated back to its equilibrium position where it overshoots again. The direction of the displacement continually alternates. From this it is clear that both the elasticity (or stiffness) of the spring and the inertial property of the mass are necessary for vibrational motion: the stiffness insures that the mass tries to return to its equilibrium position whereas inertia makes it overshoot.

The idea that all vibrational phenomena depend on the existence of a pair of quantities anal-

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ogous to stiffness and inertia is carried throughout the book. Chapter 2, for example, carries forward the analogy to other examples of free vibrations in physics, to wit: angular vibrations, acoustic vibrations, plasma vibrations, molecular vibrations, and circuit oscillations.

Damping is introduced in Chapter 3; and applications to resistance, electromagnetic, collision, and frictional damping presented in Chapter 4. Forced vibrations are introduced in Chapter 5; applications to resonant circuits, the scattering of light, dielectric susceptibility, microwaves, and water being covered in Chapter 6. Anharmonic vibrations and applications are discussed in Chapter 7. Chapter 8 introduces vibrations in two dimensions and the next two chapters illustrate the basic concepts applied to traveling waves, reflection of traveling waves, longitudinal, acoustic, and cable waves. Fourier theory is covered in Chapter 11. Dispersion is introduced in Chapter 12, and the next three chapters deal with applications to water waves, electromagnetic waves, and De Broglie waves. The remaining three chapters deal with solitary waves, plane waves at boundaries, and diffraction.

The book goes well beyond being yet another introductory treatise on springs and strings. The pattern throughout is the concise development of a model for the major topics of vibration theory and wave propagation followed by illustration and application to a very broad range of topics in physics and continuum mechanics. The presentation is incredibly clear, the emphasis on understanding concepts rather than manipulating mathematical relationships. As an introduction to the subject it is, in my view, unsurpassed and should be read first before tackling more advanced texts. I recommend it without reservation.

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Reviewed by:
Dr. J. A. Zukas
CMC, Inc.
P.O. Box 11314
Baltimore, MD