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Journal of Sound and Vibration 309 (2008) 896–897
JOURNAL OF SOUND AND VIBRATION
www.elsevier.com/locate/jsvi

Book Review

Vibration in Continuous Media, J.-L. Guyader. ISTE Ltd., London and New York (2006). 441pp., €165, US$210, £105, ISBN: 1-905209-27-4

This book truly represents a massive orderly and highly sophisticated treatment of the subject of vibration of continuous media. The subject is treated from the most microscopic level up to the evolution of the well known differential equations governing the vibratory behaviour of beams, plates and shells.

The book is not for the timid. Readers who wish to avail themselves of its contents must be prepared to devote hour upon hour to its study, familiarizing themselves with the general symbols employed and tracing systems of equations through to the end. It is fortunate that much useful research has been accomplished over the years by researchers who did not necessarily have familiarity with all of the derivations presented in the book.

The first chapter is devoted to introducing the governing equations related to the behaviour of elastic solid continuous media as well as underlying assumptions. This is considered necessary so that subsequent material may be understood.

Chapter 2 is devoted to the variational formulation for continuous media vibrations. The variational method is described in considerable detail. Attention is focused on the two functionals related to Reissner and Hamilton, which are employed in the work to follow. The notions of an extremum related to a functional are discussed.

Chapter 3 is devoted to equations governing the vibratory motion of beams. Beginning with the general three-dimensional theory the three-dimensional equations of a continuous solid elastic medium are reduced to that of the classical beam theory. It is shown how Reissner's functional or Hamilton's functional can be exploited to arrive at the beam governing differential equation. The simplifications introduced are discussed in detail. Equations for longitudinal, torsional, and bending vibrations of the straight beam are derived. The study is extended to include vibration of sandwich beams.

In Chapter 4, development of the equations governing the vibratory motion of plates is carried out based on Reissner's functional. It is shown how simplifying hypotheses lead to the plate models of Mindlin and of Kirchhoff–Love. The implications of these hypotheses are elaborated upon. Again, in-plane and transverse vibrations of plates are discussed separately. Effects of plate variations in thickness are addressed as well as evolution of plate boundary conditions.

In Chapter 5, attention is turned to the wave equation and vibratory systems to which it applies. Achievement of solutions to this equation, subject to prescribed boundary conditions, is discussed. A number of illustrative examples are worked out.

Chapter 6 is devoted to free bending vibration of beams. Simple beam vibratory solutions are introduced as well as interpretation of the beam motion as travelling waves. Vibratory motion in infinite beams is discussed. Effects of introducing rotary inertia and transverse shearing are described separately as well as their combined effect.

In Chapter 7, attention is focused on bending vibration of plates, primarily rectangular plates. Formulation of boundary conditions and solution by separation of space variables is discussed in detail as well as plate free-vibration mode shapes for various combinations of boundary conditions. A number of three-dimensional mode shapes are presented. The lesser known means of calculating mode shapes and frequencies by the "edge effect method" is introduced and discussed. The chapter ends with a discourse on the obtaining of free vibration frequencies and mode shapes for the circular plate.

doi:10.1016/j.jsv.2007.08.039

Chapter 8 is devoted to examining the complicating effects brought about by introduction of damping in vibration analysis of elastic systems. The chapter begins by examining a straight beam undergoing damped longitudinal vibration, for illustrative purposes. Interpretation of the complex angular frequency is elaborated upon. Dissipative boundary conditions are also introduced.

Chapter 9 is devoted to the forced response of vibratory systems by modal expansion. The chapter begins with calculation of the response of a simple beam to excitation forces. The orthogonality of the beam free-vibration modes is discussed as well as the introduction of beam generalized mass and generalized stiffness. It is stated that more complicated forced vibration problems such as those related to plates and shells are resolved following the same steps as those introduced for the illustrative example. The taking of damping into account is also discussed. The obtaining of response to harmonic excitation as well as impulse excitation are treated individually. Convergence of modal series solutions is discussed.

Chapter 10 deals with calculation of response of structures to forced excitation by "Forced Wave Decomposition". The chapter begins by considering a beam in torsion driven by a harmonic torque applied part way between the ends and where transient response related to starting conditions is neglected. This solution is extended to beams with discontinuities in cross section and angular driven beams in torsion. The material is extended to problems with distributed excitations and with damping. The calculation of response of rectangular plates is treated next. The book ends with a discussion of the Rayleigh–Ritz method based on Reissner's functional as well as the same method based on Hamilton's functional. Here one will find a thorough and sophisticated treatment and discussion of these two subjects.

As indicated earlier, this book is not for the timid. It will be of interest mainly to those who wish to gain a thorough understanding and appreciation for the very foundations of mechanics on which the vibratory analysis of beams, plates, and other elastic bodies is based. For most readers this will impose vast demands on their efforts and time.

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