

Vibrations and Stability of Multiple Parameter Systems. By K. Huseyin. Noordhoff International Publishing, Alphen aan den Rijn, The Netherlands. 1978. Pages vii-216. Price \$31.25.

REVIEWED BY R. H. PLAUT³

Linear, elastic systems subjected to time-independent loads are treated in this book. The systems are either discrete or are discretized by some approximation procedure, so that the equations of motion involve a finite number of generalized coordinates. Both conservative and nonconservative loads are considered, with emphasis on cases of multiple independent loading parameters. Stability is investigated dynamically from the motion about the equilibrium state of interest. This point of view leads to a unified presentation of vibration and stability concepts.

The presentation utilizes *characteristic curves* and *stability boundaries*. Characteristic curves are plots of a loading parameter versus vibration frequencies (squared). From these curves, one can determine the stability behavior of the system. If there are several independent loading parameters, stability boundaries are formed by the locus of critical loading combinations in the loading space. With two independent loads, for example, the stability boundary (or interaction curve) divides the loading plane into regions of stability and instability. In this book, properties of characteristic curves and stability boundaries are examined for various classes of loading conditions.

The first chapter reviews definitions and results in matrix theory. It is followed by a description of stability concepts. Lyapunov's definitions of stability and asymptotic stability are presented. Second-order, linear, differential equations, which have the form of the equations of motion for the systems analyzed in this book, are discussed, and the Routh-Hurwitz criterion is described. Chapters 3-6

then treat the four classes of loading conditions which the author considers.

For conservative systems, instability is always of the static (divergence) type. The fundamental characteristic curve cannot have convexity toward the origin. A similar result holds for the stability boundary. These properties lead to useful lower and upper bounds on the fundamental frequency and on critical loading combinations. Following the presentation of these concepts, the effect of damping is discussed, and examples involving elastic columns are presented.

Pseudoconservative systems contain circulatory (nonconservative, velocity-independent) forces but behave like conservative systems. Mathematically, the matrices in the equations of motion are symmetrizable. A general analysis is carried out for this class of system, and the example of a pinned column with a distributed tangential load is investigated.

Gyroscopic conservative systems are considered next. An upper bound on the fundamental frequency in the initial range of stability is obtained. Initial instability is by divergence, but dynamic (flutter) instability may occur at higher loads. Results are presented for *rotating shafts and fluid-conveying pipes*. The effect of damping is also discussed.

Finally, circulatory systems which may exhibit flutter instability are treated. Some restricted convexity properties are found, and examples involving follower loads and aerodynamic forces are described. Damping may stabilize or destabilize such systems.

This book has two main features which are notable. First of all, it treats stability from a dynamic point of view, even if instability is of the static type. By utilizing characteristic (load-frequency) curves, the concepts of stability and vibrations are interwoven. Second, the interaction effects of multiple independent loads are considered. A systematic presentation of this topic has not previously appeared in book form. These two features lead to an improved understanding of instability behavior in structural and mechanical systems. The results are interesting from a theoretical standpoint and also have important practical implications. For researchers and students with an interest in stability or vibrations, this book is an important one and is worthy of attention.

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