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Book review

Vibrations and Stability: Advanced Theory, Analysis, and Tools (2nd Edition) by J.J. Thomsen, Springer, Berlin, 2003, pp. xxii + 404, price £46, €59.95, US$89.95, ISBN 3-540-40140-7

The second edition of "Vibrations and Stability" is an accomplished and valuable book, mainly devoted to vibrations in the non-linear regime. The topics covered range from basic notions in linear vibrations, to local analysis of non-linear vibrations, bifurcations, chaos and effects of high-frequency excitation.

Chapter 1 reminds the reader of fundamental concepts, methods and phenomena associated with linear vibrations, from single-degree-of-freedom to continuous systems. There are numerous publications on basic vibration theory, therefore this chapter was wisely kept short, by avoiding the presentation of proofs or too many examples.

Chapter 2 deals with algebraic and differential eigenvalue problems, and stability. This chapter is more developed than the first one, but since the topics are also well established, only a few proofs are given and references are provided for readers interested in further details.

Chapter 3 "provides a set of classical tools for the local analysis of non-linear vibrations". It starts by presenting different sources of non-linearity. Then, using the examples of a pendulum with an oscillating support and of a hinged–hinged beam, "many of the concepts, phenomena and tools of non-linear analysis" are introduced. The classical notions necessary for qualitative analysis, like the ones of phase plane, singular points and their stability, are reviewed. Established methods — multiple scales, harmonic balance and averaging — are employed in free and forced vibrations; and the notions of primary, sub-harmonic and super-harmonic resonances are introduced. This chapter focuses on single-degree-of-freedom systems, which could have been stated in the chapter's title.

Chapter 4 employs classical methods, like multiple scales and averaging, to analyze multiple (actually two) degree-of-freedom systems where new phenomena, such as coupling between vibration modes, emerge. A few examples are analyzed in a very instructive way: an autoparametric vibration absorber, a non-shallow arch, the follower-loaded pendulum, a pendulum with a sliding disk, a string with a sliding mass and vibration in pipes due to fluid flow.

Chapter 5 is devoted to the analysis of bifurcations. As in the rest of the book, a "rather pragmatic approach is chosen". Structural instability, codimension one bifurcations in one-dimensional systems and in N-dimensional systems, and center manifold reduction are discussed. A review of different notions of stability is carried out, and, to finalize, the author returns to examples dealt with in the previous chapters, but now focusing on bifurcations.

Chapter 6 provides an introduction to chaotic vibrations, concentrating on "practical implications and applications". After defining chaotic vibrations, characteristic phase planes, frequency spectra and Poincaré maps of chaotic systems are described. The notions of Lyapunov

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exponents, attractor dimensions and basins of attraction are given. This is followed by the presentation of common routes to chaos (period-doubling, etc.) and tools for predicting the onset of chaos. A few characteristic systems displaying chaos — including some of the systems previously discussed in the book — are analyzed and some pages are devoted to spatial chaos.

Chapter 7 was not present in the first edition. It is devoted to effects of high-frequency excitation and starts by presenting an "outline of a method for conveniently analysing systems with high-frequency excitation", called the method of direct partition of motions. Important features of high-frequency excitation are then illustrated via three specific examples, presenting effects denominated as stiffening, biasing and smoothing. In Section 7.4, and mainly in 7.5 and 7.6, the analysis is extended to more general discrete and continuous systems. Finally, additional particular systems, including Chelomei's pendulum, are studied.

The book contains five appendices, which some readers may find useful. Appendix A is a very brief overview on numerical simulations. In Appendix B three major exercises are suggested. Appendices C, D and E present, in this order, a few mathematical formulas, linear modes of vibration and natural frequencies of some structural elements, and properties of engineering materials.

It is a pleasure to read this clearly written book, which achieves the aim of presenting important material on non-linear vibrations in a useful and quite understandable manner. It avoids much mathematical discussions or proofs, focusing instead on physical interpretations, with the help of illustrative examples; relevant references are given for readers interested in more information. One easily finds the connection between the subjects discussed in the different chapters and, at the end of each chapter, there are a few well-posed problems. Engineers, researchers, and particularly students and teachers in mechanical and structural engineering will find this to be a very helpful book.

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