a Hamiltonian Hopf bifurcation and the Paidoussis coupled-mode flutter. The governing equations are derived by Newtonian and Hamiltonian approaches. Various methods of solution are studied: determinant search and the Galerkin expansion. Both cantilevered pipes and simply supported pipes are discussed in details with the experimental data. Finally, long and articulated pipes are studied.

Chapter 4 extends the linear study to non-uniform pipes, sucking pipes, short pipes, and with harmonically perturbed flow. The governing equations are more complicated and closed-form solutions are not generally possible. Both analytical and experimental studies of conical pipes are given. Aspirating pipes for ocean mining are considered in detail. The collapse mode of a sucking pipe and the parametric resonance due to density pulsation for shallow immersion are illustrated. For short pipes, the shear deformation and rotary inertia become important. The analysis is actually an extension of the Timoshenko theory. After an extensive study on fluid dynamical forces, some applications are considered: the Coriolis mass-flow meter, hydroelastic ichthyoid propulsion, vibration attenuation, deep-water risers, piping vibration codes, vibration conveyance and vibration-included flow.

Chapter 5 considers the non-linear and chaotic dynamics of pipes conveying fluid. It is important to know what happens after the onset of instability. Equations are derived using non-linear axial strain and non-linear curvature. When the pipe is in vibration on a plane, two coupled non-linear differential equations are obtained after taking the first two terms of the non-linear strains and curvature. Damping is considered by using complex elastic modulus. Comparison with other work is given: Bourrieres, Rousselet and Herrmann, Sethna *et al*., and Ch'ng and Dowell. With a few rare exceptions, no general analytical solutions of the non-linear equations of motion are possible. A survey of the available numerical methods is given. Post-bifurcation phenomena for pipes with supported ends, articulated cantilevered pipes, continuous cantilevered pipes are studied. Special attention is paid to chaotic, non-linear parametric resonance and oscillation-induced flow.

The final chapter covers curved pipes with inextensional and extensional assumptions.

The appendices form an interesting part of the book. Notably, experimental methods for elastomer pipes, basic methods of non-linear dynamics and their applications for pipes conveying fluid including central manifold and normal form.

In summary, the reviewer found the book very easy to follow. Most of the material is essential. The book is recommended to research students and engineers working in the field as well as mathematicians who are interested in the applications of non-linear theory to fluid–structure interactions.

A. Y. T. Leung

AUTOPARAMETRIC RESONANCE IN MECHANICAL SYSTEMS, 2000, by A. Tondl, T. Ruijgrok, F. Verhulst and R. Nabergoj. Cambridge, England: Cambridge University Press, xiv + 206 pp. Price £35, US$ 59.95. ISBN 0 521 65079 8 (hardback)

This new book is entirely devoted to the study and elucidation of autoparametric vibration phenomena within mechanical systems and is intended to suit a wide readership, albeit one with a definite interest in the application of autoparametric systems within mechanical engineering. The authors have gone to considerable trouble to emphasise a generally integrating objective for this book, taking mechanical engineering as the core applications area. From this standpoint, physical models and mathematical treatments are introduced in a logical and progressive fashion in order to build up depth and breadth of understanding. The mathematical treatments are rigorous, yet reasonably assimilable by anyone prepared to develop the analytical tools of conventional vibration analysis a little further. The authors offer an encouraging preface to the book in which they summarize the natural symbiosis between applied mathematics and engineering, thus providing the reader with strong motivation to read the book either as a general background reference or as a workbook for specific problem solving. They correctly state that this book is the *first inventory* of autoparametric problems, notwithstanding the well-known pre-existing references that deal with the subject as a part of a more general treatment of non-linear vibrations. The authors diligently refer to these, and other, references throughout the book.

Chapter 1 starts with a physically based discussion of what autoparametric systems actually are, with an important terminology introduced in a precise but straightforward manner. The classical problems of the elastic pendulum and the coupled mass-pendulum system are described in terms of their physical constituents as well as their potential response behaviour. In this way the authors set the scene most effectively for the mathematical treatments that begin in the next chapter. Having covered this chapter the reader will have a general appreciation of the importance of the *semitrivial solution*, the fact that *at least two* subsystems are needed for any form of autoparametric interaction, that there is a necessity for some form of *non-linear coupling* between primary and secondary subsystems, and that the interplay of *stability* and *instability* between the responses of the constituent subsystems is of defining importance. The chapter concludes with a brief discussion of practical implementations, general physical models, and a subsection discussing some of the principal literature references.

The second chapter attempts to construct a generalized analysis for three different cases of a two degree of freedom (2-d.o.f.) autoparametric system, but without close ties to any particular physical model so as to introduce a common form of notation. This is an effective technique at this stage as it encourages the reader to take a necessary, but practical, non-dimensionalized notational style on board as he/she assimilates the carefully explained phenomena throughout the chapter. The need to order the terms in the differential equations arises naturally, with some initial explanations emerging. The stability of the semitrivial solution for the forced case is assessed both in the contexts of excitation and response, and with graphical representations for each. The three-axis plot for the excitation-oriented approach is deliberately inverted to give a more interpretable, and bounded, surface structure. The response-oriented approach is depicted in a two-dimensional frequency domain plot. By using both these representations the reader gains a clear appreciation of regions of stability and instability of the semitrivial solution and the important realization that regions of instability of this are in fact precursors of where a *non-trivial* solution must necessarily exist. The non-trivial case is examined next with some useful analytical treatment of stability as well as three axis, response oriented, plots for the non-trivial responses of the two subsystems. It is worth noting that the authors use the Lindstedt–Poincaré method to solve the non-trivial case but refer the reader to chapter 9 for the details, preferring to quote the results here. This is a reasonably effective technique as it does not cloud the issue in hand but does expect the reader to be disciplined enough to refer to the later explanation as necessary. The remaining two cases of parametric and self-excited systems are subsequently also treated as semitrivial and non-trivial sub-cases, with analytical and numerical discussions of the former and analytical and discursive treatments of the latter. The concept of bifurcation is introduced and the rather complicated analysis of self-excitation is linked to the further details provided in chapter 7. The net effect of chapter 2 is to leave the reader with a clear appreciation of the principal features of autoparametric interaction in 2-d.o.f. systems in terms of relatively straightforward mathematical language, which can then be built upon in subsequent chapters.

Following on from this, chapter 3 returns to the physical domain of mechanical engineering, and the reader is persuaded that the simpler quadratic coupling non-linearities of the systems studied in chapter 2 can usefully be extended to cubic order in an attempt to model single masses with 2-d.o.f., such as might be encountered in practical rod and beam constraint problems, for example. It is important to note that the authors continue to avoid *modelling* specific problems at this stage in the book, presumably for the sake of getting the reader to a sufficiently advanced point of rigorous, but general, understanding. The same three basic cases of forced, parametric, and self-excited systems are invoked, effectively consolidating the chosen notational style, with the reader left to work up the parametric case on his/her own. Key stages of the analysis for the externally excited case are presented, and domains of attraction are introduced by using a specific numerical plotting technique based around a chosen excitation function. For the self-excitation problem the authors state that their approximate, averaged, semitrivial solution is, in fact, also achievable by means of the harmonic balance method. The non-trivial solution is characterized at the end of the chapter in the form of observations, these being clearly explained and physically meaningful.

Chapter 4 takes the specific case of the well-known mass–spring–pendulum system and derives the differential equations depicting the vertical translation of the mass and the angular motion of the pendulum by recourse to Lagrange. The style of the preceding chapters is maintained, with an explicit non-dimensionalization leading to governing equations in the house style. The phenomenon of *quenching* of the primary system is explained for one of the principal system solutions, with the appropriate physical link made to the pendulum's damping characteristics and the *saturation* of the primary (spring–mass) system. Bifurcation and stability of the non-trivial solutions are discussed in greater detail in this chapter and intriguing phenomena associated with large-scale pendulum motions are also discussed. The chapter ends again with useful summary points.

The previous system is extended in chapter 5 into a chained system of n masses and springs in series, with the possibility of each mass being coupled to a pendulum, thus leading to a multi-d.o.f. definition. For the purposes of discussion a two mass, two pendulum, system under harmonic excitation is non-dimensionalized and then analyzed in detail.

Ship motion is a well-known application of autoparametric interaction and this forms the subject of chapter 6 which begins with a physical, and referenced, introductory discussion of possible motions. Heave-roll motion is analyzed, with the governing equations stated, noting that they are based on a direct analogy with the spring–mass–pendulum system of chapter 4. The accompanying discussion of the ship motion provides an acceptable context for this, also linking back to the spring–mass–pendulum diagram of chapter 1. Ship buoyancy is represented by the spring stiffness and the authors show that non-linear stiffness effects are relevant and that they can be accommodated. More complex motions involving heave-pitch-roll are assessed by means of further analogies involving two masses and coupled pendula with plenty of numerical stability data provided.

The authors develop the theme of physical system modelling and analysis in chapter 7 by examining the important problem are of flow-induced vibrations. This is a long and ambitious chapter, starting with a range of physical system models and then moving firmly into dynamical systems territory to better equip the reader for results interpretation. A simple bluff body with a pendulum is considered initially (referring back to chapter 1 again) and it is convincingly shown that the pendulum can effectively reduce the flow-induced motions of the body. Adding dry friction to the pendulum changes the global dynamics of the system because the semitrivial solution stabilizes over a broad range of cross-flow velocities. Vortex shedding is also included in this chapter although the reader is directed to a reference for the actual modelling stage. The second half of the chapter is motivated by the additional response phenomenology of the cross-flow systems and the interesting case of chaotic solutions due to the presence of the Šilnikov bifurcation. Although slightly different in feel to what precedes it this half chapter is invaluable in presenting the reader with a clearly explained digest of the powerful techniques of qualitative analysis, with obvious relevance to the engineering topics which anchor the book. Comprehensive, relevant, and up-to-date references are given throughout this chapter.

Chapter 8 continues the somewhat accelerated level of chapter 7 with an in-depth appraisal of rotor problems, taking flexible supports and gyroscopic coupling into account. A full Lagrange derivation is given showing that the non-linear coupling terms are quadratic. The system is initially linearized showing the presence of combination resonances, then the semitrivial and non-trivial solutions are examined in detail. The book concludes by reviewing appropriate mathematical methods including averaging, Lindstedt–Poincaré, harmonic balance, transformation to normal forms, treatment of Mathieu systems by normalization of the time-dependent vector field, local and global bifurcations, and Mathieu systems with both viscous and non-linear damping.

This is an up-to-date, well-referenced, book which achieves its objective of unravelling much of the complexity in the analysis necessary for understanding autoparametric systems and also in showing that these systems are widespread, and therefore physically important. It is therefore highly recommended for all engineering dynamicists who wish to develop their practical vibration analysis skills into an applications area that is all too frequently considered to be overly difficult and abstruse.

M. P. CARTMELL

MODELS AND REALITY IN SYSTEMS DYNAMICS' 2000, by Hans Günther Natke, Hannover, Germany: UNSER Verlag, 90pp, €19·40, ISBN 3-934208-03-7

The aim of this book is to put dynamics within a framework of systems theory and engineering. Central to this aim is a discussion of mathematical modelling and the inherent uncertainties in models and measurements. In essence, this work is a summary of the modelling philosophy of the author and his significant contributions over many years. The book starts by defining systems and their models within a framework of set theory, and emphasizes that models must be "goal-oriented". Measured data are considered the best information on the actual system, and its use in the model building processes is considered. System identification is interpreted as test supported model building, and the need for validated and verified models is highlighted. The sources of model uncertainties and methods of their reduction are discussed. The author then moves on to methods of model correction (or model updating) and reviews the available residual types, identification methods and regularization. The book ends with a summary approaches to model-based diagnosis, and finally some comments on the future, concentrating on holistic models, non-stationary signals and active systems.

This is a short book, with only 68 pages of text. With such a large scope most topics can only be mentioned briefly. However, there are a large number of references, and the reader is directed to these for more detailed information. Furthermore, space has not allowed the examples to be discussed in depth. Thus, this is not a book for the engineer learning modelling and identification techniques. More it is for the scientist or engineer who is already experienced in these techniques, who would appreciate a more philosophical and fundamental view of the modelling process.

M. I. FRISWELL