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REVIEWS

Erosion and Sedimentation. By P. Y. JULIEN. Cambridge University Press, 1995. 280 pp. ISBN 0-521-44237-0. £35.

This book, essentially covering the erosion, transport and deposition of sediments in inland waters, is a welcome addition to the existing standard textbooks in the subject area, most of whose original editions are now over 20 years old.

The book is logically planned out, well written with clear explanations in good English, and is nicely laid out and printed. There are plenty of explanatory figures, and a host of worked examples, both on fundamentals and on practical calculations, and more extended case studies. The examples are often accompanied by step-by-step methods of calculation, with worked numerical values, which are of great benefit to the practitioner. There are also numerous exercises and problems (some for computer solution) for the student to tackle, marked with an asterisk coding to indicate importance. Some of these problems have answers given, but many (including some of the most interesting) do not, so that the student may be left in doubt as to whether he has obtained the right answer.

The first five chapters (about 80 pages) cover fundamentals of fluid flow in general, and flow–particle interaction especially. These include a lot of mathematical derivations and compilations of the key partial differential equations, which will be valuable for teaching and reference purposes, but large sections are not used subsequently in the remainder of the book. These chapters will appeal to the more academic reader. The next six chapters cover velocity profiles and sediment transport including incipient motion, bedforms, bedload, suspended load and total load. Most aspects are covered, including some, such as turbulent mixing of washload, and hyperconcentrations (including rheology and mud flows), which are not always included in other books. Practical matters such as how to measure sediment transport in rivers, and a variety of standard methods of measuring the grainsize distribution of sediment samples, are included. A wide variety of theoretical predictors of the main sedimentary quantities are presented and compared. The final chapter on reservoir sedimentation contains assorted information and methods, including density currents. These latter chapters, including such down-to-earth matters as tables of crop management factors to permit calculations of soil erosion among tall weeds, straw or wood chips, will appeal to the practitioner as well as the academic.

The bibliography betrays a somewhat traditional approach to the subject, since 80% of the references are more than 10 years old. This feeling is reinforced by an appendix which details the Einstein sediment transport method, conveying an implication that this 45-year-old method is superior to more recent methods. The index is adequate, but oddly laid out. For example, 'angle of repose' is indexed under P for 'properties – angle of repose'.

Some material is reproduced uncritically. For example, a figure by Simons (1957) which shows the angle of repose of similarly shaped grains apparently increasing with grainsize is presented without any comment or explanation as to how this could be so (many previous books have done likewise).

Perhaps the most awkward feature for non-Americans is the mixed use and juxtapostion of 'English' (ft/slug/sec) and SI units; and Fahrenheit and Celsius temperatures. For example, problem 8.3 gives discharge in ft^3/s, velocity in ft/s and grain diameter in mm; problem 8.4 gives depth in m and temperature in °F; and problem 8.6 gives flow velocity in m/s and temperature in °C.

The title of the book could mislead those interested in marine sediment transport, since coastal and estuarine waters are not mentioned at all, and the effect of waves is not considered even for lakes and reservoirs. Despite these niggles, this book is well worth having on the shelves of students, teachers, researchers and practising engineers for educational, reference, and practical how-to-do-it purposes.

R. L. SOULSBY

Global Physical Climatology. By D. L. HARTMANN. Academic Press, 1994. 408 pp. ISBN 0-12-328530-5.

Sometime in the late 1950s and early 1960s climatology began a transition from being a subject mainly within the realm of geographers to becoming firmly established as a physical science. It was no longer sufficient to describe and explain qualitatively the features of the atmosphere; it became necessary to account quantitatively for the features or, as happens commonly, attempt to understand why such attempts at quantification were failing. A number of inter-related forces might explain this transition. The growth of computing power gave the opportunity for increasingly sophisticated models of the atmosphere–ocean–ice–biosphere system to be developed. Numerical weather prediction provided an early impetus and this was closely followed by the recognition that human activity might be leading to significant climate change. Also, data from satellite instruments began to give a global view of the climate system; analysis of that data has provided some puzzles in need of a solution.

Dennis Hartmann's aim is to present a modern book describing the physics of the global climate system at a level appropriate for undergraduate and Masters students. Hartmann acknowledges the difficulty of describing the underlying physics and interactions in a book of manageable size and 'when faced with a choice between providing easy access to an important concept and providing a rigorous and comprehensive treatment, [he] has chosen easy access'. The book undoubtedly fills a niche in the market but my enthusiasm for it has been tempered by the publisher's choosing to make the book anything but easily accessible to the student, by giving it a price tag of over £40.

The book opens with an overview of the climate system. There is an early scare when, after only eight lines, we have precipitation quoted in inches and temperature in Fahrenheit – but things soon improve! The early part of the book is concerned with the global energy balance and a quite detailed description of radiative processes. Attention then shifts to the energy balance of the surface and the complexities in calculating the latent heat flux. This rather static view of the climate system then gives way to a discussion of how the atmosphere and ocean transport heat and other properties. The chapter on the ocean was, for me, the high point of the book as it provided an excellent balance between physical description of the system and quantitative explanation of the features.

The final five chapters then integrate this groundwork into a discussion of the climate system and, in particular, the mechanisms of climate change due to both natural causes and human activity, on the way describing the structure of climate models; this description is an important one for students as it shows the complexity of the radiative and fluid dynamical interactions between the different components of the climate system. Some unevenness is evident. There is a surprisingly detailed discussion of the way variations in the Earth's orbit (on 10000 to 100000 year timescales) translate into changes in the latitudinal and seasonal variations in the input of solar radiation. It is, nevertheless a valuable discussion; it serves as an important example of how qualitative descriptions of phenomena, so common in other text books in this area, can be turned into quantitative analysis.

Of course, a book like this is likely to have a few problems. I believe it takes some courage for anyone to write a book at this level; the author bares his or her 'soul' over a wide range of disciplines and there is a substantial chance that a reviewer will be a specialist in an area that the author is not! And so I worried a little in the chapter on radiative transfer when Hartmann generally uses rather vague terms like 'intensity' and 'flux' in the text, while using the more rigorous terms 'radiance' and 'irradiance' in the figures. I also felt uneasy with plots and tabulations of things such as the surface heat budget components without a clear indication to the student that these are estimates often based on very simple models with barely adequate input data. Finally, I was unsure what background was being assumed of the student. Some very basic concepts are introduced in detail but words like 'geostrophic', 'baroclinic' and 'barotropic' creep in without introduction and the glossary is unable to help. Since Hartmann is continuing the tradition of fine textbooks from the Atmospheric Science Department at the University of Washington, it seemed surprising that he did not point the student in the direction of some of his colleagues' books for more enlightenment.

K. P. SHINE

Stability, Instability and Chaos: an Introduction to the Theory of Nonlinear Differential Equations. By P. GLENDINNING. Cambridge University Press, 1994. 388 pp. ISBN 0 521 41553 5. £45.00 (hardback), £17.95 (paperback).

The advances made over the last thirty years in bifurcation theory and stability theory are now playing a major role in fluid dynamics, and many readers of *JFM* will find this book both useful and stimulating. Although it contains a substantial amount of mathematical theory, including some theorems only proved quite recently, many researchers in fluid mechanics will have had some contact with this new mathematics, at least in an informal and intuitive way. Glendinning provides a systematic and accurate account of this material which can be understood even with a fairly modest background in pure mathematics. The style is informal and attractive to read, yet a great deal of material is covered. This means, of course, that much detail has been omitted; some theorems are stated but not proved, but the author is always careful to provide good references for those who wish to understand these topics in more depth. The point of view from which the book is written is that of an applied mathematician who wants to understand and make use of the new theory.

It is interesting to compare this work with older texts on nonlinear differential equations to see how the subject has developed. This book almost everywhere emphasizes the qualitative and geometric aspects of differential equation theory rather than quantitative and analytic methods. Now that ordinary differential equations can be integrated numerically even by relatively cheap computers, it is just these qualitative and topological properties of the solutions which need to be understood by those involved in applications. Interestingly, these qualitative aspects are much more demanding mathematically than the older quantitative techniques; a guide such as this work provides is therefore especially valuable.

Although the material is developed from first principles, this is not a first course in differential equations, and the reader will need to be familiar with the basic techniques of exact solutions before approaching this work. Much of the book is based on lectures given at Cambridge and Warwick universities, and could form a useful basis for a variety of final year undergraduate courses in advanced differential equations or dynamical systems; I suspect, however, that only very able undergraduates will completely master all this material. This is definitely not simply yet another book containing a collection of examples of nonlinear phenomena with no attempt at a coherent development. Although the style is informal, this is a systematic account of the subject. Nevertheless, most readers will find this book easier going than either Arnol'd (1983) or Guckenheimer & Holmes (1983), although those who wish to see more details will probably need to consult these texts. Generally this book will be most useful for graduate level courses; indeed, almost all graduate students working in fluids would benefit from understanding it.

After a brief introduction to the distinction between the qualitative and quantitative aspects of differential equations, the various definitions of stability such as Liapounov and asymptotic stability are covered, showing how they relate to linear stability. Linear theory is then developed economically using the Jordan normal form. Chapter 4 considers the problem of resonances and the Poincaré linearization theorem; stable and unstable manifolds are introduced, the stable manifold theorem is proved and the concept of structural stability is discussed.

In chapter 5 a fairly detailed treatment of two-dimensional dynamical systems is given, including a concise classification of stationary points and the Poincaré–Bendixson theorem concerning the existence of periodic solutions; the stability of periodic solutions using Floquet theory is covered in chapter 6. Chapter 7 deals with perturbation theory, which is used to investigate dynamical phenomena such as frequency locking, subharmonic resonance and hysteresis. This material can be found in older books, such as Minorsky's text on nonlinear oscillations, but nevertheless the succinct and elegant treatment of these topics given here is very enjoyable.

Chapters 8, 9 and 10 deal with local bifurcation theory, both for steady solutions of differential equations and for maps, which then leads on to the bifurcation theory of periodic solutions. The treatment is at an elementary level, but forms an excellent introduction to the subject, and the reader will find a clear account of topics such as the saddle-node and the transcritical bifurcations. The discussion goes as far as quasi-periodic behaviour and Arnol'd tongues, but for a fuller discussion of this, and more advanced topics, the reader is referred to more detailed texts.

The final chapters on chaos and global bifurcation theory will probably be the hardest for students to master. The chapter on chaos covers horseshoe maps and the special case of unimodal maps; this leads on to the universality results on period-doubling sequences. The rest of the chapter is essentially a step-by-step guide to Sharkovskii's theorem, while the final chapter gives the reader a taste of some of the issues involved in homoclinic bifurcations and their role in chaotic differential equations.

The book is well-written and illustrated. The reference list and notes for further reading are especially helpful, and every chapter has a collection of well-chosen examples at the end. I found a number of minor misprints, but generally the book has been carefully produced. This introduction to nonlinear differential equations will prove a very useful addition to the *JFM* reader's library, and will play an important role in the education of future graduate students.

C. A. Jones

REFERENCES

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