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Preface

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Chaos is an ubiquitous phenomenon that arises in many natural and artificial systems where nonlinearity is present (Thompson & Stewart 1986; Moon 1992). Nowhere is this important and robust phenomenon more easily observed, studied and exploited than in electronic circuits. Three reasons for this can be identified. First, there exist exceedingly simple and inexpensive circuits costing less than a paperback, which are ideal for heuristic experimental investigations of the diverse chaotic phenomena that have been identified in the more complex systems of solid and fluid dynamics, chemical kinetics, etc. Second, the physics of the electronic devices used in these circuits is a well-understood and mature branch of electrical engineering. Excellent mathematical models exist, allowing the experimental observations to be reproduced by computer simulation (Parker & Chua 1989) with great accuracy; and the bifurcational structure of these nonlinear models can be analysed by using the new topological techniques of dynamical systems theory. It is indeed the case that no other chaotic physical systems are known which are amenable simultaneously to experimental, numerical and analytical studies, giving correlations which are not only qualitative but often quantitative to within 5%. Third, for applications which call for a source of real chaotic signals (such as secure communication systems and neural networks), electronic circuits provide the simplest and cheapest source of such physical signals. Moreover, such circuits can be readily mass-produced in practical applications as inexpensive integrated circuit chips.

This volume contains a collection of *tutorial* and *review* papers on the theme of chaotic behaviour in electronic circuits. The first four papers are *experimental* in nature and include a careful selection of the simplest electronic circuits from representative classes (autonomous, non-autonomous, hysteresis, etc.) which exhibit chaotic behaviours. Most of these circuits can be assembled by the uninitiated reader in less than an hour, and are therefore ideal for those beginners in chaos who are more inclined to experimental observations than computer simulations. Virtually all of the phenomena studied in these four papers are unified and subsumed into a single *universal* circuit in the next paper. This circuit provides a universal paradigm for studying and exploiting chaos, and will appeal not only to the novice but also to specialists of nonlinear dynamics and chaos. The last four papers present an up-to-date review of the dynamcis, control and applications of chaos to three representative information-processing systems in electrical engineering; namely to digital filters, neural networks, and communication systems.

References

Moon, F. C. 1992 *Chaotic and fractal dynamics.* New York: Wiley.

Parker, T. S. & Chua, L. O. 1989 *Practical numerical algorithms for chaotic systems.* New York: Springer.

Thompson, J. M. T. & Stewart, H. B. 1986 *Nonlinear dynamics and chaos.* Chichester: Wiley.