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Book Reviews

Stability and Complexity in Model Ecosystems—Robert M. May (Princeton, NJ: Princeton University, 1973, 235 pp.). *Reviewed by P. M. Allen, Service de Chem. Physique, ULB, Brussels, Belgium.*

In the early chapters of this book, May introduces and explains the basic concepts involved in the mathematical modeling of ecosystems. The development is clear and logical, covering deterministic and stochastic representations with and without time-lag. Particularly good is the explanation of the importance of the community matrix and the ensuing discussion of the stability of a given set of populations.

The section devoted to the possible relation that may exist between the stability and the complexity of an ecosystem is most important. Enormous confusion clouds this issue, as ecological disaster is often identified with "instability," and because stability with respect to fluctuations of the existing populations in interaction, of the environment, and those representing the invasion of new species, are mixed indiscriminately. May shows that, whether or not a rule such as MacArthur's "theorem" (relating stability to the number of trophic links) has a foundation in nature, it is not derivable in any obvious way from considerations of the stability of a complex system with respect to the fluctuations of the existing populations. He shows that, *a priori*, it would seem more probable that complexity would diminish this type of stability than increase it. The considerations of stability with respect to environmental fluctuations lead to a formula governing niche overlap—a most interesting result.

The book, however, re-poses the question with more urgency and more clarity than before: What then is the connection between complexity and the various types of stability mentioned above? This should be a point of major interest over the next few years.

This book then represents an excellent text which should be obligatory reading for all those wishing to understand and discuss the mathematical modeling of ecosystems.

Stability of Motion—A. T. Fuller, Ed. (London: Taylor and Francis, and New York: Halsted (Wiley), 1975, 358 pp.). *Reviewed by G. H. Hostetter, Department of Electrical Engineering, California State University, Long Beach, CA 90840.*

In March 1875, the usual biennial notice was issued, giving the subject for the next Adams Prize of the University of Cambridge: *The Criterion of Dynamical Stability*. Edward John Routh (1831–1907) was awarded the prize in 1877 for his brilliant essay "Stability of a Given State of Motion," which included his celebrated stability criterion.

Routh's work had deep roots in the control theory of Airy and Maxwell and in the related work of Cauchy, Sturm, and W. K. Clifford. In the period 1840–1850, George Biddel Airy (1801–1892) became the first person to apply differential equations to control systems. He did so in connection with governor-regulated clockword for astronomical telescopes, initiating the study of the *dynamics* of control. Routh married Airy's eldest daughter in 1864.

James Clerk Maxwell (1831–1879) and Routh entered Cambridge University as undergraduates in 1850. Maxwell's 1868 paper, "On Governors," established the connection between stability and characteristic root location. Having won the Adams Prize in 1857 with an essay on the stability of Saturn's rings, Maxwell became one of the four examiners who set the subject of stability criteria for the 1877 prize.

This edition begins with a helpful historical and mathematical introduction by the editor. In addition to "Stability of a Given State of Motion," two earlier papers by Routh are included, together with a portion of his book on rigid body dynamics. A little-known but key contribution of Clifford is reprinted, as is a translation of a closely related paper by Sturm.

The book assembles and makes accessible important source material in control theory and will make a valuable addition to the researcher's library.

Teoria Generală a Problemelor de Extremum cu Aplicatii la Sistemele de Control Optimal (General Theory of Extremal Problems with Application to Optimal Control Theory)—Constantin Vârsan (Bucharest, Romania: Editura Academiei Republicii Socialiste România, 1974, 385 pp., in Romanian). *Reviewed by A. Halanay, Bucharest University, Bucharest, Romania.*

When Pontryagin, Gamkrelidze, and Boltyanskii published their first paper on optimal control about 20 years ago, it seemed that a new area of mathematics was born, with specific methods and results. This impression was produced mainly by the linear time optimal problem with the corresponding bang-bang result that looked very nonclassical. However, as the mathematical community became attracted by the new problems in optimal control, it was discovered that much of the new theory could be included in classical variational calculus by using a device of Valentine. This approach was developed by L. Berkovitz and was published about 15 years ago. A new step in the growth of the theory is related to the work of Hestenes, Dubovickii and Milyutin, Halkin and Neustadt, and Gamkrelidze: it consists in the consideration of the problem in terms of abstract optimization theory. It has been proved that optimal control theory may be viewed as mathematical programming in infinite-dimensional spaces and that the maximum principle of Pontryagin can be obtained from general multiplier rules.