Applied Mathematics and Systems Engineering

Advances in Control Systems: Theory and Applications. vol. 1. C. T. Leondes, Ed. Academic Press, New York, 1964. x + 365 pp. Illus. $13.

Substantial advances have been made during the past years in the area concerned with the applications of mathematics to the field of automatic control systems. This area of applied mathematics and systems engineering has expanded from linear control theory to the realms of sample data and adaptive control system theory, largely through the intelligent expansions and applications of the formal mathematics of analysis and stochastic processes.

Advances in Control Systems gives a comprehensive treatment of certain pertinent mathematics, with good examples of its applications to specific systems. It is important in such a subject that both the mathematics and engineering considerations relevant to the proper applications be integrated in an understandable manner. This has been accomplished rather well despite the fact that the book is made up of sections that were written by different individuals.

It is also commendable that the editor has consciously refrained from presenting some of the efforts made by engineers to apply heuristic procedures and concepts of artificial intelligence to this field of systems engineering. All of the text is based on sound and pertinent mathematical precepts. Although it is important to realize that eventually current basic research on the principles of information processing by intelligent living nervous systems will provide new engineering concepts in the field of automation, these efforts have not yet reached the stage where significant disciplinary material can be presented to engineers as useful tools for design or synthesis.

The book commences with a section, by M. Aoki, devoted to the basic stochastic description of an optimal or near optimal control system in suitable form for design synthesis. J. S. Meditch then presents the maximum principle of design optimization and applies it to some advanced guidance problems. More complex missile systems in which structure and aerodynamic problems require description by partial differential equations are detailed by P. K. C. Wang. The next section of the book, by H. Halkin deals with geometric and topological concepts of analysis and synthesis for control systems described by difference equations. In the following section P. R. Schultz deals with the logistic aspects of complex system optimization through local successive optimizations in a piecemeal manner. The book concludes with a section, by F. H. Kishi, devoted to on-line computer control of systems in which the missile reentry problem is used as a prime example.

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Lockheed Research Symposium on Space Science

Auroral Phenomena: Experiments and Theory. First Lockheed Research Symposium on Space Science. Martin Walt, Ed. Stanford University Press, Stanford, Calif., 1965. x + 170 pp. Illus. $6.50.

This book is a collection of ten papers that were presented at a symposium on auroral phenomena held in Palo Alto, California, in January 1964. Such a collection of papers represents a progress report in a field of research rather than a comprehensive treatise, but I found this particular collection rather valuable because the papers are concise and generally well prepared.

C. T. Elvey's brief and up-to-date paper on auroral morphology skips the well-known descriptions that are available in standard texts (for example, *The Polar Aurora* by Stoermer) and concentrates on new phenomena and new relationships, most of which have been reported or proposed in the last 2 or 3 years.

In a paper on television observations of auroras, T. Neil Davis briefly but clearly demonstrates the power of a new tool for auroral research. The television system reported on was able to take photographs of auroral forms, at the rate of 24 frames per second, of auroras that in some cases were invisible to the unaided eye. Davis makes it clear that the sensitivity of this system can be improved.

A. Dalgarno's paper is replete with references, and in less than six pages of text he discusses the pertinent physical processes that occur when energetic charged particles interact with the atmosphere.

Kinsey A. Anderson's paper on balloon measurements of x-rays in the auroral zone proceeds at a more leisurely pace and is more complete. In fact, this paper and R. L. Leadabrand's paper are essentially comprehensive reviews of their subjects. I would recommend Anderson's article to anyone who wishes to become acquainted with, or to keep up with, auroral x-ray research. Leadabrand presents a review of auroral electromagnetic measurements that is comparable in length and clarity to Anderson's paper.

B. J. O'Brien presents a succinct review of rocket and satellite experiments related to the precipitation of energetic particles into the atmosphere and the resulting optical emission. Most of the discussion in the papers by Anderson and O'Brien concerns electrons with energies far above those normally associated with auroral optical emissions. However, consideration of these electrons was correctly included as part of the symposium because such electrons do constitute an important part of the overall phenomena.

J. E. Evans presents a somewhat lengthy paper on the experimental methods for making coordinated auroral measurements using ground observatories and instruments borne by aircraft and satellites.

Joseph W. Chamberlain's discussion of the present status of auroral theories is particularly intriguing because it illustrates a remarkable change that has taken place during the past five years. Prior to about 1960 auroral theories abounded and were vigorously defended by their authors. There was approximately one auroral theory per auroral theorist. Chamberlain implies that now, in the mid 1960's, no theory survives. To quote Chamberlain, "My own feeling on the present status of auroral theory is that we have not really progressed very far. As proponents of special theories or speculations, most of us tend to be rather tenacious about this model or that, but I doubt whether this attitude can be objectively justified in any particular case." It appears that the