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

wealth of detailed experimental data has left little speculative ground on which the theorist may gain a secure footing. From now on, auroral theories may have to be correct.

The book closes with a short summary, by Anders Omholt, of a few particular points of interest.

As I mentioned at the beginning of this review, this book is a brief progress report (with the exceptions of the more complete review papers by Anderson and Leadabrand). The papers will be of limited value to those who are not already familiar with auroral phenomena. This book would make a good companion to *Physics of the Aurora and Airglow*, by Joseph Chamberlain, along with the 1962 symposium "Theoretical Interpretation of Upper Atmosphere Emissions" which was published as volume 10 of the journal *Planetary and Space Science* (1963). My only negative comment is a mild one directed at the publisher: the cost of the book exceeds four cents per page, which seems too high in view of the quality of the printing and the format. Surely a way could be found to publish conference proceedings in less time and at a lower price.

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Organic Chemistry: A Reference Book

The Acyclic Aliphatic Tertiary Amines. Leonard Spialter and Joseph A. Pappalardo. Macmillan, New York, 1965. xvi + 512 pp. Illus. $18.

This is not a book that anyone will read, or will intend to read, from cover to cover; it is a one-volume reference work, primarily a tabulation of 710 compounds, each one acyclic, aliphatic, and tertiary, ranging from C_3H_9N to $C_{87}H_{177}N$, as defined by the title. Entries are further limited to those that contain only carbon, hydrogen, and nitrogen, although both monoamines and polyamines up to $C_{21}H_{50}N_6$ are listed (with saturated and unsaturated hydrocarbon groups). The literature survey included *Chemical Abstracts* through mid-1961, so that all examples covered by the title and described through 1960 are likely to be included. There are approximately 1600 unduplicated references (pp. 451–501). The indexing is nicely handled by means of a formula index (pp. 511–512) so that entries are quickly located.

The first 93 pages will interest most organic chemists and advanced students, for those pages are devoted to historical background, nomenclature, general properties, and general preparative methods. The review of preparative methods (pp. 14–93) is complete and includes discussion of the scope and limitations of the many methods recited.

The first specific entry, obviously, is trimethylamine (p. 100), which occupies 13 pages that cover all physical properties, natural occurrence, methods of preparation, and derivatives; each item of information is supported by literature references. It appears that any worthwhile, published item about trimethylamine is cited here, either per se or by way of references. Most of the subsequent entries are very much shorter, of course; ethynyldimethylamine rates only a few lines (two derivatives, one reference).

I made a number of sample checks to locate assorted bits of published information with which I was already familiar; in each instance I was able to locate the item quickly. I noted only a very few misspelled words and typographical errors.

Clearly this book will be extremely useful (even indispensable) to those actively engaged in research in aliphatic amine chemistry. We will appreciate having it in the office and laboratory, within instant reach. Others will consider the price high and will forego the convenience of owning a personal copy, knowing that every good chemical research library will have the volume in its collection.

All those who use the volume will certainly hope that this is the first of a multivolume set which will provide similar coverage of all of amine chemistry. But this is unlikely; amine chemistry *in toto* is much too vast, and the job much too formidable, for any two-man team. The authors chose to cover a very small corner of this very large field, and they have done a painstaking and thorough job.

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Prigogine School Techniques

Statistical Mechanics of Charged Particles. R. Balescu. Interscience (Wiley), New York, 1963. xiv + 477 pp. Illus. $15.

Statistical Mechanics of Charged Particles, by R. Balescu, volume 4 of the series Monographs in Statistical Physics and Thermodynamics, edited by I. Prigogine, is based on nonequilibrium statistical mechanics as developed by I. Prigogine and his coworkers at the Université Libre de Bruxelles. Balescu has contributed greatly to this new approach to statistical mechanics and is, therefore, in a position to give an accurate account of the subject. Indeed, he does this in a masterful and rigorous fashion.

The theory is not easy since it deals with the foundations of the subject. However, Balescu's book can be read profitably by serious, second-year, graduate students in this country. The book is largely self-contained and is very clear and readable. Many complex details and much additional material are relegated to appendices.

Much of the customary work in plasmas is based upon equations that are "derived" by intuitive arguments. The newer approaches in statistical mechanics seek to derive phenomenological equations rigorously, starting with the basic dynamical description of the entire system. The dynamical equations describing the system involve interactions among all the particles that comprise the system and in general are quite intractable. However, the perturbation methods of modern quantum theory provide a tool that enables one to solve the dynamical equations in a *formal* manner. The "solution" consists of infinitely many terms in a series whose convergence is quite doubtful. Nevertheless, in some real sense the series represents the solution to the equations. Very briefly, the method of the Prigogine school consists, first, in identifying terms in the perturbative expansion for the time evolution of various Fourier coefficients of the phase-space distribution function (Wigner distribution function for quantum systems). The terms in this expansion are identified and classified with the aid of a systematic diagram technique. A study of the properties of classes of diagrams then leads to a judicious choice of terms (usually infinite in number), which yield the largest contributions to a given type of physical