expansion. Other aspects of leaf expansion are dealt with in articles by H. W. B. Barlow and C. R. Hancock and by E. Bünning. W. T. Williams contributes an interesting account of etiolation phenomena. The final section of the symposium, with contributions by F. L. Milthorpe, G. E. Blackman, H. L. Penman and D. J. Watson, is concerned with the influence of external factors on leaf growth and underlines the importance of such studies in any attempt to improve crop production.

It will be evident from a consideration of the subjects dealt with and from the names of the contributors that this symposium is an excellent compilation. In a work of this type there are always certain gaps that could be filled ; an account of leaf meristems would have been helpful and few of the authors have paid any attention to the potentialities of, or the results already achieved by, the supply of organic substances to plants growing in aseptic culture. The organizers of the symposium are to be congratulated, however, on producing a book which should be of great interest, not only to those concerned with agricultural production, but also to any student of plant morphogenesis. A. Allsopp

ANALOGUE COMPUTERS

Analog Computer Techniques

By Prof. Clarence L. Johnson. Pp. xi+264. (London : McGraw-Hill Publishing Company, Ltd., 1956.) 45*s*.

Electronic Analog Computers

(D-c Analog Computers). By Dr. Granino A. Korn and Theresa M. Korn. Second edition. Pp. xiv+452. (London : McGraw-Hill Publishing Company, Ltd., 1956.) 56*s*. 6*d*.

ELECTRONIC analogue computers were developed mainly during the Second World War, primarily in connexion with radar and predictors. The first uses and many of the techniques arose in Britain. The past decade has seen a tremendous growth of the number and popularity of this type of computer, especially in the problems of automatic control where non-linear effects can so easily be studied by direct simulation. Reasons for this increasing use are the simplicity in understanding the method of operation and the ease with which they can be designed and built. This is exemplified by the large number of small special-purpose machines that have been 'home-constructed'. There is a big demand for the all-too-few books on this subject.

"Analog Computer Techniques", by C. L. Johnson, is a new-comer in this field. The introduction gives as the purpose of this book the reduction in the training period of analogue computer operators. It is, however, by no means an operator's handbook but a detailed survey of the various electronic methods by which mathematical functions may be represented and operations performed, together with a study of the various techniques now available for the solution of differential equations. In the classification of computing machines the analogue variety is subdivided into 'physical-analog' and 'mathematical-analog' computers and goes on to claim that the book will deal mainly with the latter. If this had been true, the text would not have been half so valuable as it turns out to be. The most important uses of, and the major advances in, engineering science in guided missiles, servomechanisms and automation have been achieved by physical analogue machines known in British terminology as 'simulators'. The difference between the use of these two classes of computers is greatest when the problems are non-linear. Here, in many cases, the mathematical equations may be difficult or impossible to formulate, and where, as is demonstrated intentionally in section 7.5, it is only too easy to find the right answer to the wrong equation. It then becomes necessary to use physical simulation of the problem as in 'backlash', hysteresis, saturation and other non-linear functions. This is dealt with adequately and at length in Chapter 7, "The Representation of Non-linear Phenomena".

In the main the mathematics has been kept at a fairly low level, but surely not at such an elementary stage that the author thinks it necessary to justify in an appendix the equivalence of $j\omega$ and the operator p. An exception is that of section 9.7, where the mathematics involves the theory of functions of complex variables and is quite out of keeping with the remainder of the book. It is also unnecessary and could with advantage be deleted. A blatant mistake is the use of complex coefficients, in equation 9.15, which represent physically unrealizable systems and lead to equation 9.18, which is incorrect.

A misleading treatment of Nyquist's criterion is less excusable. The proof and theorems given under this heading are an extension due to H. W. Bode (which is not acknowledged) and have little connexion with this famous criterion. Nowhere is it explained that it is a criterion of stability. In fact, in the very section, A.4, "Conditions of Stability", in which it should be utilized it is never mentioned. Instead, the author uses the out-of-date and cumbersome Hurwitz–Routh set of criteria (Hurwitz's name is also omitted).

Apart from this theoretical flight which is a mistake and is, in any event, only a very small portion of the book, the treatment of computer elements, multipliers, function generators and examples of methods of applying and solving problems is good. The chapter on the more modern digital integrating differential analyser has special merit. References are given at the end of each chapter and are exclusively American.

"Electronic Analog Computers", by G. A. and T. M. Korn, is the second edition of a very successful book which has had the privilege of being first in the field for several years.

The complete absence of the use of a machine as a simulator has been rectified in the second edition which now deals very adequately with this subject, giving techniques directly applicable to non-linear control systems. Circuit details are now given of methods by which these non-linear functions can be simulated by diodes, including the generation of functions of more than one variable. The book is up-to-the-minute in dealing with multipliers by including F.M.–A.M. and time division methods of multiplication. There is even a small section on random processes and the production of required forms of signals for computer use. The treatment of stability is still totally inadequate, and the Nyquist criterion as quoted is not strictly accurate.

On the whole, however, it remains the best American text on this subject. A large bibliography, together with author- and subject-indexes, complete the book. It is refreshing to note the British references included. J. C. West