books dealing with the techniques and the gadgets, many of them very bad.

The merit of Mr. Russell's book is that it deals with both sides of the coin; both the theoretical and the practical, side by side. The theoretical work is elementary, but design principles and methods are clarified thereby, being circuit techniques for various data processing, logical operations upon signals, modulation, switching and gating, and a host of other operations.

In my opinion the book is most suited to the practical design engineer at the beginning of his career, after graduation, and perhaps to the provide the research student with some necessary background of technique. Unfortunately, very few references are given to guide the young reader further—so necessary in this vast field. But there are plenty of numerical examples for him to feed upon, on his way.

Most of the detailed circuits shown in diagrams are to transistors, and little advice is given as to their relative merits and uses. The book is fairly well indexed.

Colin Cherry.

Solutions Numeriques des Equations Algebriques, Volume II

This is the second volume of Professor Durand's treatise on the numerical solution of algebraic equations. The first volume, which I reviewed in this Journal, Vol. 5, p. 32, was concerned with the solution of single equations in one variable, while this volume deals with systems of equations. Of its 445 pages, some 422 pages are devoted to two problems of fundamental importance: the solution of simultaneous linear algebraic equations, including the inversion of matrices, and the calculation of the eigensystems of matrices. There is only one short chapter on the solution of general systems of equations.

Chapter I provides the theoretical background for the treatment of the two fundamental problems. This is a difficult field to present since a large amount of material must be covered, and this must be done without upsetting the balance of the book. Professor Durand has been remarkably successful in condensing this material into a reasonable space without rendering it unintelligible.

The next three chapters are devoted to the solution of linear equations and deal respectively with direct methods, iterative methods, and the inversion of matrices, of which the third is closely related to the first since direct methods are used. The standard direct methods are covered very thoroughly, and my only criticism of this section is of the treatment of numerical stability and of attainable accuracy. Two examples will serve to illustrate my point.

When discussing the use of small pivotal values it is suggested that this leads to inaccuracy when the pivot has been obtained as the difference of two comparatively large quantities. This is quite misleading since the use of a small pivot, even at the first step, will result in a poor solution even though no rounding errors have yet been incurred.

As a second example, when discussing the improvement of an inverse, obtained by a direct method, by the iterative procedure $X_{i+1} = X_i (I - AX_i)$ it is suggested that this is usually of little value. It is useless to discuss the effectiveness of this procedure without some reference to the nature and precision of the arithmetic used in computing the original inverse, and performing the iterative procedure. In fact if the formula is written in the form $X_0 = X_0 + X_0(I - AX_0)$ and $X_0$ is computed by a direct method using single-precision arithmetic, then $X_0$ will, in general, be a substantial improvement on $X_0$ provided inner products are accumulated when computing $I - AX_0$.

The section on iterative methods is concerned primarily with full sets of equations. Naturally a special discussion of the techniques which have been developed in the last decade for the solution of linear systems arising from partial differential equations could not be included, but much of the discussion on convergence rates will be of interest to workers in this important field. I was pleased to find that the superiority of direct methods for non-specialized sets of equations was emphasized.

The last 250 pages are devoted to a detailed examination of techniques for the solution of the algebraic eigenvalue problem. Considering how rapid have been the advances in this field over the last ten years, Professor Durand is to be congratulated on giving an account which covers almost all the important techniques which had been used up to the time of publication. The value of his examination is enhanced by the fact that virtually all the techniques which he discusses have been programmed by the group at Toulouse. The most important of the techniques which have been omitted are Householder's reduction of a symmetric matrix to tri-diagonal form and Francis' Q-R transformation with its associated device for dealing with complex conjugate eigenvalues of real matrices, though probably the former was in use only at N.P.L. and the latter only by Francis when this book went to press. In my review of the first volume I regretted the absence of an assessment of Rutishauser's Q-D algorithm.

In this volume there is, in fact, not only a discussion of the Q-D algorithm but also a very thorough treatment of Rutishauser's L-R algorithm. It is to be hoped that this will do much to popularize the use of the L-R algorithm, though I would like to have seen even greater emphasis given to the importance of a preliminary reduction to Hessenberg form.

My one criticism of this section is much the same as that on the section on direct methods of solving equations. Although I find myself in fairly general agreement with the assessment of the relative stability of the various techniques, I feel that the reader is not given much insight into the factors which make one method very stable, while another, apparently quite similar, method is violently unstable. In discussing methods which involve similarity transformations using elementary matrices, the significance of pivoting receives little attention; pivoting seems to be regarded as a method of avoiding a breakdown of the process when zeros arise in the key positions, rather than something which is, in general, of vital importance for stability.

A very large number of numerical examples are given throughout the text and these have been well chosen to illustrate the effectiveness and deficiencies of the techniques. There is also a collection of interesting exercises, some theoretical and some numerical, at the end of each chapter. This is by far the most comprehensive account which is available of the practical aspects of matrix computations, and I heartily recommend it to all serious students of the subject.

J. H. Wilkinson.