## Book Reviews (continued from p. 237)

The most fascinating chapter is probably that dealing with connections between information theory and physics. Examples are given of the transmitter power required to send teleprinter signals across interplanetary space against a background which may consist of astronomical bodies at various temperatures. On a smaller scale an interesting new version of Maxwell's demon is presented and shown to have a striking connection with information theory.

It is unfortunate to have to report also that the book is peppered with a number of small mistakes which are likely to throw the inexperienced reader off the track; for example, the word "not" is omitted here and there and this leads to some rather puzzling paragraphs. In spite of this, however, the book can be thoroughly recommended as background reading to anyone concerned with communication or computers.
S. Gill.

Numerical Methods for Scientists and Engineers, by Richard W. Hamming, 1962;.411 pages. (London: McGraw-Hill Publishing Co. Ltd., 85s. 6d.)
This is the third book on Numerical Analysis published in the "International Series in Pure and Applied Mathematics" and it maintains the high standard set by its predecessors, Householder (1953) and Hildebrand (1956). This collection might become known as "The Triple-H" on numerical methods! The volume under review was written with the junior/senior level of American universities and colleges in mind; the style is rather chatty in places, but this is not unusual in American texts. As the title implies, it is written for scientists and engineers, but the author, a mathematician, does not pander unduly to their whims ( $i$ is used for the square root of minus one). The exercises are chosen to illustrate and supplement the text and are not derived from practical problems encountered by scientists and engineers.

The book comprises thirty-two plus one chapters arranged in four Parts as follows: I, The discrete finite difference calculus; II, Polynomial approximation-classical numerical analysis; III, Non-polynomial approximation; IV, Algorithms and heuristics. The last, or " $\mathrm{N}+1$ "th chapter, entitled "The art of computing for scientists and engineers," is of particular interest and might have been better placed as chapter 0 , since it outlines the kind of questions which everyone should ask himself before embarking on computing work. The treatment of difference methods given in Part I is seldom found in general books on numerical methods, but as the author is at pains to emphasize, for some purposes it has decided advantages over the more conventional differential approach, for example in the study of errors. The chapters in Part II on predictor-corrector methods for the solution of differential equations, and those in Part III on periodic functions and their applications to filters are particularly well written, as is to be expected of Dr. Hamming. All the material in the book is relevant for scientists and engineers. and it is treated with about the right amount of rigour, Unfortunately, the undergraduate is neither helped nor encouraged to pursue any topic which might be his particular interest or concern. The 44 references at the end of the book are only books which should be in any self-respecting college library. There are few references to original papers and those which are given are relegated to footnotes. The lack of such references can only be due to the admitted haste with which the author wrote the book, but it does detract from its value because students (particularly Americans) do tend to
stick rigidly to a single text and they shut their eyes to all else. This is a bad attitude of mind but this text, along with many others, tends to foster such a narrow outlook.

## Dr. Hamming takes as his motto:

"The purpose of computing is insight, not numbers."
This idea is very worth-while and ought to be brought home even to experienced computer users who are, all too often, slaves to the machine rather than vice versa. Chapter $N+1$, which elaborates on this motto, ought to be read by all computer users whether actual or potential, and the remainder of the book provides a good grounding in numerical methods for the latter.
G. N. Lance.

The Dynamics of Automatic Control Systems, by E. P. Popov, 1962; 761 pages. (London: Pergamon Press, 75s.)
This is an English translation of a textbook which has become a student standard inside the U.S.S.R. In the main the teaching of automatic control engineering in the U.S.S.R. takes place in six large identical electrical engineering institutes. Each institute has a total of about 6,000 students engaged on a six-year course and is divided into a number of departments, two of which are devoted to control engineering. One is concerned with heavy industrial control. Although it is not stated in the book, Professor Popov is head of the latter at the institute situated at Kiev. In his career he has spent some time in research at the famous (to the West) Institute for Automatics and Telemechanics in Moscow.

Comparison with university students in Great Britain is difficult. The Russian student starts at the Institute at 18 with less technical preparation than his counterpart in the U.K., but after six years his standard of course work is matched in control engineering only by the best of postgraduate courses. This textbook thus deserves close study by teachers and those interested in education in the control field.

It is a large book of some 760 pages and tribute must be paid to Dr. Booth of Birkbeck College for his energy and determination in translating so large a work. The success of the translation owes much to the fact that Dr. Booth himself is a computer and control engineer of distinction.

The work is divided into five separate parts. The first, 150 pages long, is devoted to an exhaustive introduction with the title "General Information"; it covers the concept of the closed loop, describes many practical installations and finishes with a history of the development of control theory. This is national in character and makes no mention of work outside the U.S.S.R. It does, however, make a change to read of Polzunov inventing the first automatic regulator in 1765 in place of the inevitable speed governor of Watt. Vishnegradskii published a general theoretical paper on automatic regulation in 1876 and became the Russian father of automatic control theory. Differentiation is also made between theory before the Revolution and after, up to the present day. Liapunov and Chebyshev are already familiar names and it is interesting to see them placed in the Russian perspective.

Part II forms the theory of linear systems, dealing with transient and steady-state frequency response analysis. It concludes with the Nyquist criterion of stability, only the name is now Mikhailov.

The third part is an extension of linear theory to cover "dead time" or delay, distributed parameters, and a short chapter on sampled data systems.

Part IV is reserved for non-linearities and deals again with transient and frequency response analysis and stability.

Part V contains numerical and graphical methods of solution.

The outstanding feature is the attention to detail and com-
pleteness. Within the scope of transient and frequency response behaviour one has the feeling that nothing has been omitted.
J. C. West.

# Correspondence 

"The Calculation of Power Spectra"

## To the Editor,

The Computer Journal.

## Dear Sir,

As a communication engineer, I would like to raise one or two questions arising from Mr. Swinnerton-Dyer's paper (1962).

Firstly, engineers find it confusing (rather than a harmless abuse of language) to use formulae (2.1) and (2.2) indiscriminately; so they call the one with positive exponential the Fourier transform, the other the inverse Fourier transform, and functions G and S Fourier mates. There was at one time some inconsistency in the choice of which should be the transform operation and which the inverse, but the above choice is now usual among engineers, who claim for it the backing of Campbell and Foster (Campbell and Foster, 1948). Secondly, in terms of single-sided integrals the engineer's power density is four times the cosine transform of the autocovariance, a relationship which is consistent with the independent definition of power spectrum (Carson, 1931). I am not clear how to relate Mr. Swinnerton-Dyer's factor of two to engineering usage.

I have been working on a fairly general FORTRAN program for finding power spectra (with the assistance of I.B.M. under their Research Endowment scheme) and would like to underline Mr. Swinnerton-Dyer's comments on the uselessness of trying to obtain higher-frequency components than the spacing of ordinates warrants: I have seen one computer program for Fourier series which claims to be able to go to any harmonic order in spite of using only a fixed small number of ordinates! The reason for this claim is that the program provides for interpolation between ordinates, but, in fact, the components so evaluated will be representative of the interpolation routine rather than of the tabulated function, and in the last resort can be expected to give a power spectrum decreasing at least as the square of the frequency. (The Fourier integral of any well-behaved function eventually decreases at least as fast as inverse frequency, and the power spectrum is proportional to the square of the amplitude.)

However, it is legitimate to interpolate between tabulated points if one has some independent knowledge of the values of the function between tabulated points, and so can devise a specific interpolation formula which gives an approximation to these values. For example, if a plot of the function on $\log /$ linear scales is only slightly curved, one might take an exponential approximation between tabulated points, but with a different exponent for each segment. Two forms of error then arise. If between two points $F(x)$ is the function and $\phi(x)$ the approximation, there is a difference function $D(x)$; then by the additive property of Fourier transforms
the difference between transforms of the true function and the interpolating function must be the transform of $D(x)$, and this gives an indication of the magnitude of error involved. The second error arises from the discontinuity of derivatives at the end of each interpolating segment. This error must be qualitatively proportional to the degree of discontinuity, but I should welcome any advice on the magnitude of this "window" $\dagger$ effect in the case when the function is continuous, but not its derivatives.

Any form of smoothing can in principle only destroy information, and it is tantalizing that one cannot explicitly remove the effect of a known window. If a signal function $G_{s}(t)$ is multiplied by a window function $G_{w}(t)$, e.g. $G_{w}(t)=1$ for $-T<t<T$ and $G_{w}(t)=0$ elsewhere, the Fourier transform $S_{0}(f)$ for the combination will be a convolution

$$
S_{0}(f)=S_{s}(f) * S_{w}(f)
$$

But if $S_{w}(f)$ can be determined from the known $G_{w}(t)$, why cannot there be a "de-convolution" so as to extract $S_{s}(f)$ from $S_{0}(f)$ ? This looks like a problem of factorization of $S_{0}(f)$ which one expects to be generally intractable; but is it absolutely impossible to find a numerical method of de-convoluting?
AMF British Research Laboratory, D. A. Bell. Blounts Court, Sonning Common,
Reading, Berks.

## References

Campbell, G. A., and Foster, R. M. (1948). Fourier Integrals, Van Nostrand, New York.
Carson, J. R. (1931). "The Statistical Energy-Frequency Spectrum of Random Disturbances," Bell Syst. Tech. Journ., Vol. 10, p. 374.
Swinnerton-Dyer, H. P. F. (1962). "The Calculation of Power Spectra," The Computer Journal, Vol. 5, p. 16.

To the Editor,
The Computer Journal.
Dear Sir,
The criticism of the current Honeywell FACT Manual which was made at the B.C.S.-N.C.A.T. Conference and reported in the Journal was at the time not wholly unjustified. That manual was an interim production. It has served well those who got results from an imperfect compiler in the early days.
$\dagger$ Engineers refer to the spectral effect of the finite bounds on the sample as a "window" effect, because it is as though one were looking at an infinite extent of function through a window of limited dimensions. The spectral effect of the finite bounds is, of course, additional to the sampling uncertainty with a finite length of a stochastic function.

