Part V contains numerical and graphical methods of solution.

The outstanding feature is the attention to detail and completeness. 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"† 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?

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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.

† 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.

However, a new FACT Manual is due shortly and it will be of the same attractive standard as the other Honeywell Systems Manuals.

A pleasantly readable manual for a programming language is a normal adjunct to that language when it is first specified, and it is desirable that it should remain adequate as a description and programming guide once a compiler has been written and is in everyday operation. Whether it is reasonable to expect so much is questionable. Recent experience suggests that there are two stages in the life of a data-processing language at which its manual can properly exist in fair prose. Those are, on the one hand, before the implementation gets properly under way, and on the other, once the compiler has been 95% checked out. The intervening period can be hard on any but the most nebulous description. The FACT Manual which is now about to be released marks FACT'S arrival as a working tool.

Yours faithfully,
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Computers and School Timetables

The honorary editors note with pleasure the recent appointment of Professor C. C. Gotlieb, Director of the University of Toronto Computation Centre, to the post of Editor-in-Chief of *Communications of the Association for Computing Machinery.*

Considerable interest was shown in the paper "The Construction of Class–Teacher TimeTables" presented by Professor Gotlieb at the recent I.F.I.P. Congress in Munich. The regular discussion was followed by a special meeting at which some 40 persons were present. It became evident that work on this subject is in progress at many institutions. A list of groups interested in timetable construction was drawn up and copies are available from the Assistant Secretary of The British Computer Society at the address shown on p. ii of cover. Professor Gotlieb has undertaken to circulate any short summaries of progress which are submitted to him, to the organizations listed.

Southampton Branch Conference

A two-day conference on *Computers in Local Government* will be held by the Southampton Branch of The British Computer Society on 2 and 3 April 1963. Further particulars will be published later.