The Solution of Helmholtz Equation in Elliptical Domains

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The propagation of electromagnetic (EM) waves in hollow, perfectly conducting waveguides has been studied recently by Kretzschmar [1] in an excellent paper. Extensive numerical data are presented for the cutoff wavelength on 19 successive modes.

The paper is also of interest in other fields of applied sciences, since in the case of TM modes the problem is mathematically equivalent to that of an elliptical cylinder, subject to a sudden temperature change at the outer surface of the cylinder [2].

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The numerical evaluation of the solution requires the zeros of ordinary and modified Mathieu functions and the calculation of integrals involving the functions.

Kirkpatrick and Stokey's paper [2] describes also the evaluation of the temperature equation by the use of a digital computer giving results for ellipses having eccentricities of 0.60, 0.70, 0.80, and 0.90.

Kretzschmar [1] uses a Bessel-function product-series approach, while Kirkpatrick and Stokey [2] make use of a hyperbolic function series. It should also be pointed out that only the even TM_{cmp} ($m=0, 2, 4 \cdots$, $p=1, 2 \cdots$) in Kretzschmar [1] have their equivalent in Kirkpatrick [2].

References

[1] J. G. Kretzschmar, "Wave propagation in hollow conducting elliptical waveguides," *IEEE Trans. Microwave Theory Tech.*, vol. MTT-18, pp. 547–554, Sept. 1970.
[2] E. T. Kirkpatrick and W. F. Stokey, "Transient heat conduction in elliptica plates and cylinders," *J. Heat Transfer, Trans. ASME*, pp. 54–60, Feb. 1959

Letters

Instantaneous Frequency-Measuring Receivers

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The instantaneous frequency-measuring receiver (IFR) is becoming widely known to microwave systems engineers, but as a consequence of the defense applications its origins are obscure. The pioneering work on the phase-discriminator technique, which is the basis of most modern IFR systems, was done in the Mullard Research Laboratories, Redhill, Surrey, England. A brief account of the work and a record of one of the first signal observations with this type of receiver may be of interest.

Some of the unique characteristics of IFRs have already been detailed in the literature and are not repeated here. The IFR was perhaps one of the first significant postwar innovations in microwave receiver design. The principle for measuring frequency in terms of the phase delay of a signal propagated down a known length of transmission line must be nearly as old as electromagnetic science. However, the technique for applying this principle to broad-band receivers, whereby the frequency of any signal received in more than an octave range may be determined to an accuracy limited primarily by the signal duration, yet without the use of tuned filters or other circuit adjustments, is comparatively recent.

Research towards this end was started in the Mullard Research Laboratories in 1954, and the first task was to broadband the hybrid junction, which was the building brick in many microwave circuits. Following a proposal by Hicken [1], and in collaboration with other workers, the phase-reversal hybrid was developed [2], [3]. In essence this was a proximity coupler inserted in one arm of an otherwise symmetrical four-port ring.

The application of this hybrid junction to broadband IFRs was recognized, but with a single junction used as a phase discriminator

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