VII. MOLECULAR BEAMS*

Prof. J. R. Zacharias
Prof. J. G. King
Prof. C. L. Searle
R. S. Badessa
V. J. Bates
H. H. Brown, Jr.
D. Buhl
R. Golub
E. L. Kamen
F. J. O'Brien
J. E. Steelman
C. O. Thornburg
R. Weiss

A. CESIUM BEAM TUBE INVESTIGATION

Successful completion of the varactor multiplier chain has resulted in an output power of approximately 1 mw at a frequency of 9192 mc, the 560^{th} harmonic of a 16.4-mc crystal oscillator. Two amplifiers were required for this chain, a 16.4-mc power amplifier delivering approximately 15 watts, and a unity gain amplifier at 131 mc, to suppress undesired harmonics and to match impedance levels. This second amplifier could be obviated by a continuation of the developmental work on the 16.4 mc-131 mc multiplier stages.

A crystal oven has been ordered which has a reported temperature stability of 0.01°C. Incorporation of the 16.4-mc crystal in this oven should yield sufficient frequency stability to perform measurements of the beam-tube characteristics.

V. J. Bates

B. SUPERCONDUCTING LEAD CAVITY

The surface condition of the metal in a superconducting microwave cavity is an important factor affecting the final Q of the cavity. Therefore, we have conducted several experiments to find ways of obtaining a smooth strain-free surface on the two pressed lead cups that will make up our cavity. Both electropolishing and chemical-polishing techniques have been tried.

In the electropolishing experiments the lead cavity itself served as the anode and a carbon rod was used for the cathode. The electrolyte consisted of 60 grams of anhydrous sodium acetate, 315 ml of glacial acetic acid, and 80 ml of water (1). A current density of 50 ma per square centimeter was maintained for 5 minutes. Some reduction in the amount of large-scale roughness of the surface was noted. However, the resulting surface had a dull texture that indicated that considerable small-scale roughness was still present.

The chemical-polishing solution contained one part 30 per cent hydrogen peroxide to 4 parts glacial acetic acid (1). The solution was allowed to remain in the cavity for from 5 to 10 seconds. The results, at best, were variable.

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Two lead cups have been electropolished and chemically polished with reasonable success, so that the cavity and cooling equipment (2) have been assembled and are now being pumped down.

J. E. Steelman

References

1. W. S. Tegart, The Electrolytic and Chemical Polishing of Metals in Research and Industry (Pergamon Press, London, 2d edition (revised), 1959).

2. J. E. Steelman, Superconducting lead cavity, Quarterly Progress Report No. 61, Research Laboratory of Electronics, M. I. T., April 15, 1961, p. 109.

VIII. STATISTICAL COMMUNICATION THEORY

Prof. Y. W. Lee
Prof. A. G. Bose
Prof. I. M. Jacobs
Prof. J. B. Wiesner
Dr. A. D. Hause
V. R. Algazi
R. A. Bruce
D. F. De Long, Jr.
C. L. Feldman
H. Hemami
F. J. Hernandez
D. J. Sakrison
M. Schetzen
H. L. Van Trees, Jr.
S. Weinreb
W. S. Widnall

A. WORK COMPLETED

1. SOME PROBLEMS IN NONLINEAR THEORY

The present study has been completed by M. Schetzen. In May 1961, he submitted the results to the Department of Electrical Engineering, M.I.T., as a thesis in partial fulfillment of the requirements for the degree of Doctor of Science. The study will also be published as Technical Report 390.

Y. W. Lee

2. SYNTHESIS OF OPTIMUM NONLINEAR CONTROL SYSTEMS

This study was completed and presented by H. L. Van Trees, Jr. as a thesis in partial fulfillment of the requirements for the degree of Doctor of Science, to the Department of Electrical Engineering, M.I.T., May 1961.

Y. W. Lee

3. APPLICATION OF STOCHASTIC APPROXIMATION METHODS TO SYSTEM OPTIMIZATION

This study has been completed by D. J. Sakrison. It was submitted as a thesis in partial fulfillment of the requirements for the degree of Doctor of Science, Department of Electrical Engineering, M.I.T., May 1961, and will also be published as Technical Report 391.

A. G. Bose

4. A STUDY OF IMPULSE RESPONSES IN THE RECORDING AND REPRODUCTION OF SOUND

This study has been completed by J. Hernandez-Figueora. It was submitted as a thesis in partial fulfillment of the requirements for the degree of Master of Science, Department of Electrical Engineering, M.I.T., May 1961.

A. G. Bose

5. ERRORS IN MEASURING CORRELATION FUNCTIONS BY ORTHOGONAL EXPANSION

This study has been completed by R. A. Bruce. It was submitted as a thesis in partial fulfillment of the requirements for the degree of Master of Science, Department of Electrical Engineering, M.I.T., May 1961.

M. Schetzen

B. EXPERIMENTAL MEASUREMENT OF CORRELATION FUNCTIONS BY ORTHOGONAL EXPANSION

1. Introduction

It is known that an n^{th}-order correlation function can be represented by a set of orthogonal functions (1, 2, 3). For example, consider the crosscorrelation function of the random time functions $f_1(t)$ and $f_2(t)$, which is defined by the relation

$$\phi_{12}(\tau) = \lim_{T\to\infty} \frac{1}{T}\int_0^T f_1(t)\, f_2(t+\tau)\, dt \tag{1}$$

For $\tau \geqslant 0$, this can be written as

$$\phi_{12}(\tau) = \sum_{i=1}^{\infty} a_i \psi_i(\tau) \tag{2}$$

where $\{\psi_i(\tau)\}$ is a complete set of orthonormal functions; that is, they satisfy the relation

$$\int_0^{\infty} \psi_i(\tau)\, \psi_j(\tau)\, d\tau = \begin{cases} 1 & i = j \\ 0 & i \neq j \end{cases} \tag{3}$$

The coefficients a_i are given by

$$a_i = \int_0^{\infty} \phi_{12}(\tau)\, \psi_i(\tau)\, d\tau \tag{4}$$

By considering only those sets that are possible impulse responses of linear systems, it can be shown that the coefficients of the expansion are the outputs of realizable networks (1). In particular, the coefficients are measured by using the circuit shown in Fig. VIII-1. Furthermore, the correlation function itself can be realized as the impulse response of the network shown in Fig. VIII-2. Therefore, the measured correlation function is a continuous function, rather than a point-by-point plot. In utilizing the orthogonal expansion technique errors can be introduced because of practical restrictions. First, in most applications it is practical to use only a finite number of networks