

XII. NONLINEAR CIRCUITS

Prof. E. A. Guillemin
Prof. S. J. Mason

Prof. H. J. Zimmermann
N. DeClaris

T. E. Stern
R. D. Thornton

A. PIECEWISE LINEAR NETWORK THEORY

Some of the principles of piecewise linear transfer function synthesis summarized in the Quarterly Progress Report, July 15, 1955, were reduced to practice in the design and construction of a generator of arbitrary functions of a single voltage variable. Function generators of this type are necessary adjuncts to analog computers, and in high speed machines bandwidth considerations demand all-electronic function generators. Units that produce piecewise linear approximations of a given function, making use of thermionic or semiconductor diodes, have been utilized successfully for this purpose in the past. However, the setting up or "programming" of functions on these devices is usually a long and laborious procedure. It consists of adjusting slopes and intercepts of various line segments until the desired approximation is produced. This is a tedious iterative procedure, since changes in any one parameter affect a considerable portion, if not all, of the function.

To avoid these difficulties a diode function generator consisting of a summation of eleven triangle-type unit functions was constructed as a B.S. thesis in the department of General Science at M.I.T. by Frank Spada of the Instrumentation Laboratory, M.I.T., with the cooperation of that laboratory. A typical function as it is set up on the device is shown in Fig. XII-1. The dotted triangles indicate the contributions of the individual unit functions. Note that the ordinate of the function at each breakpoint is determined only by the magnitude of the particular unit function centered over that point. This permits independent adjustment of each ordinate and is a decided advantage

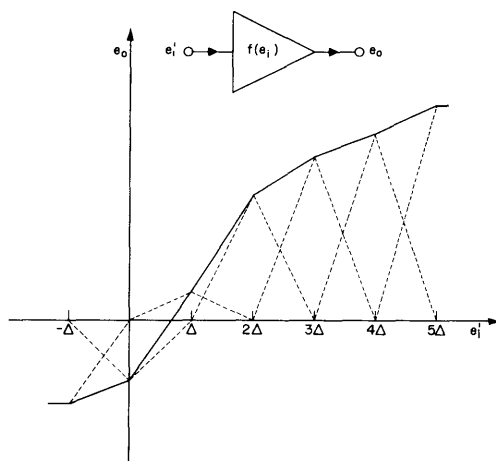


Fig. XII-1. Function synthesized with triangle-type unit functions

(XII. NONLINEAR CIRCUITS)

over previous schemes. The device has a static error of less than 1 per cent.

This practical application indicated that the theoretical synthesis procedures are feasible and, indeed, superior to other methods. The information gained from the design of the generator of functions of a single variable, e. g. , determination of the most desirable types of diodes, optimum biasing methods, and so on, has been applied to preliminary design work on a generator of arbitrary functions of two variables based upon summations of pyramid functions.

T. E. Stern