
CHAPTER 1

INTRODUCTION TO MODERN NETWORK THEORY

1.1 MODERN NETWORK THEORY

A generalized filter is shown in Figure 1-1. The filter block may consist of inductors, capacitors, resistors, and possibly active elements such as operational amplifiers and transistors. The terminations shown are a voltage source E_s , a source resistance R_s , and a load resistor R_L .

The circuit equations for the network of Figure 1-1 can be written by using circuit-analysis techniques. Modern network theory solves these equations to determine the network values for optimum performance in some respect.

The Pole-Zero Concept

The frequency response of the generalized filter can be expressed as a ratio of two polynomials in s where $s = j\omega$ ($j = \sqrt{-1}$, and ω , the frequency in radians per second, is $2\pi f$) and is referred to as a transfer function. This can be stated mathematically as

$$T(s) = \frac{E_L}{E_s} = \frac{N(s)}{D(s)} \quad (1-1)$$

The roots of the denominator polynomial $D(s)$ are called poles and the roots of the numerator polynomial $N(s)$ are referred to as zeros.

Deriving a network's transfer function could become quite tedious and is beyond the scope of this book. The following discussion explores the evaluation and representation of a relatively simple transfer function.

Analysis of the low-pass filter of Figure 1-2a results in the following transfer function:

$$T(s) = \frac{1}{s^2 + 2s^2 + 2s + 1} \quad (1-2)$$



FIGURE 1-1 A generalized filter.

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Clifford Lane



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