**Tapered Lines**

Note all our multi-section transformer designs have involved a *monotonic* change in characteristic impedance, from $Z_0$ to $R_L$ (e.g., $Z_0 < Z_1 < Z_2 < Z_3 < \ldots < R_L$).

Now, instead of having a *stepped* change in characteristic impedance as a function position $z$ (i.e., a multi-section transformer), we can also design matching networks with *continuous tapers*.

A tapered impedance matching network is defined by two characteristics—its *length* $L$ and its taper function $Z_1(z)$:
There are of course an infinite number of possible functions $Z_1(z)$. Your book discusses three: the exponential taper, the triangular taper, and the Klopfenstein taper.

For example, the exponential taper has the form:

$$Z_1(z) = Z_0 e^{az} \quad 0 < z < L$$

where:

$$a = \frac{1}{L} \ln \left( \frac{Z_L}{Z_0} \right)$$

Note for the exponential taper, we get the expected result that $Z_1(z = 0) = Z_0$ and $Z_1(z = L) = R_L$.

Recall the bandwidth of a multi-section matching transformer increases with the number of sections. Similarly, the bandwidth of a tapered line will typically increase as the length $L$ is increased.
Figure 5.21 (p. 260)

Solution to Example 5.8. (a) Impedance variations for the triangular, exponential, and Klopfenstein tapers. (b) Resulting reflection coefficient magnitude versus frequency for the tapers of (a).
Q: But how can we physically taper the characteristic impedance of a transmission line?

A: Most tapered lines are implemented in stripline or microstrip. As a result, we can modify the characteristic impedance of the transmission line by simply tapering the width $W$ of the conductor (i.e., $W(z)$).

In other words, we can continuously increase or decrease the width of the microstrip or stripline to create the desired impedance taper $Z_1(z)$. 