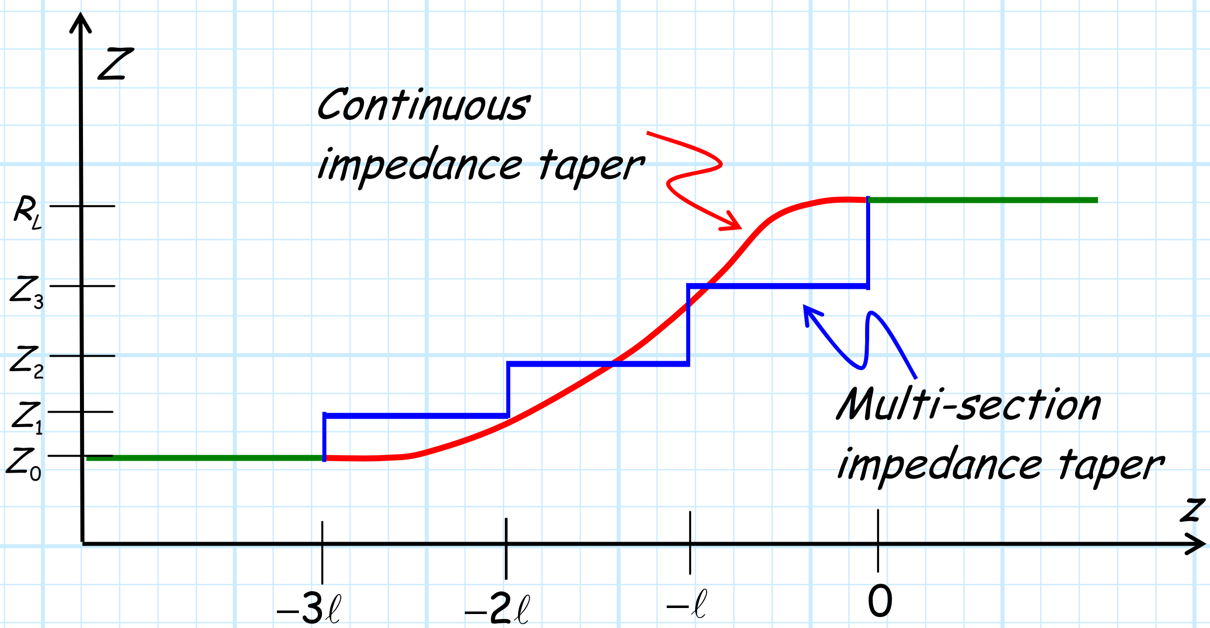
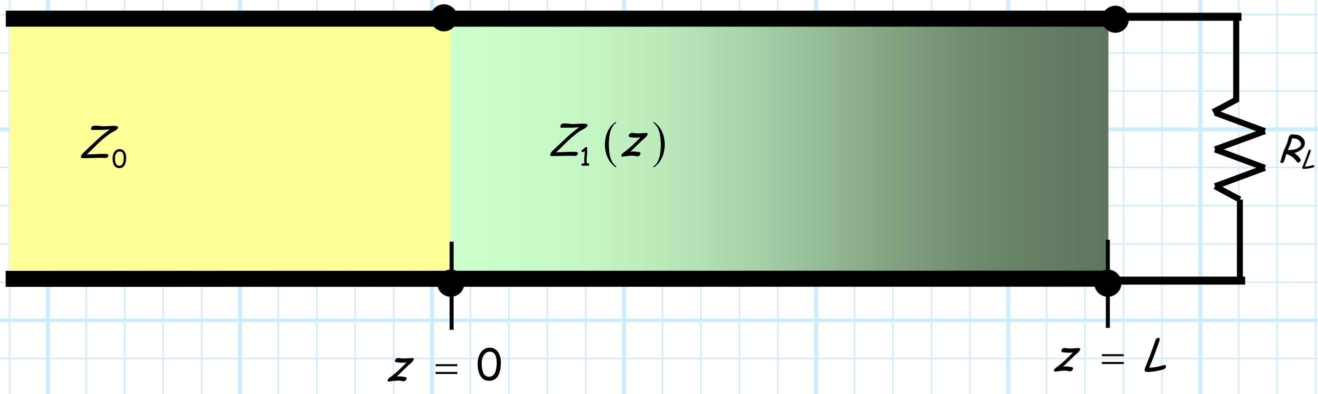
Tapered Lines

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

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:

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

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.

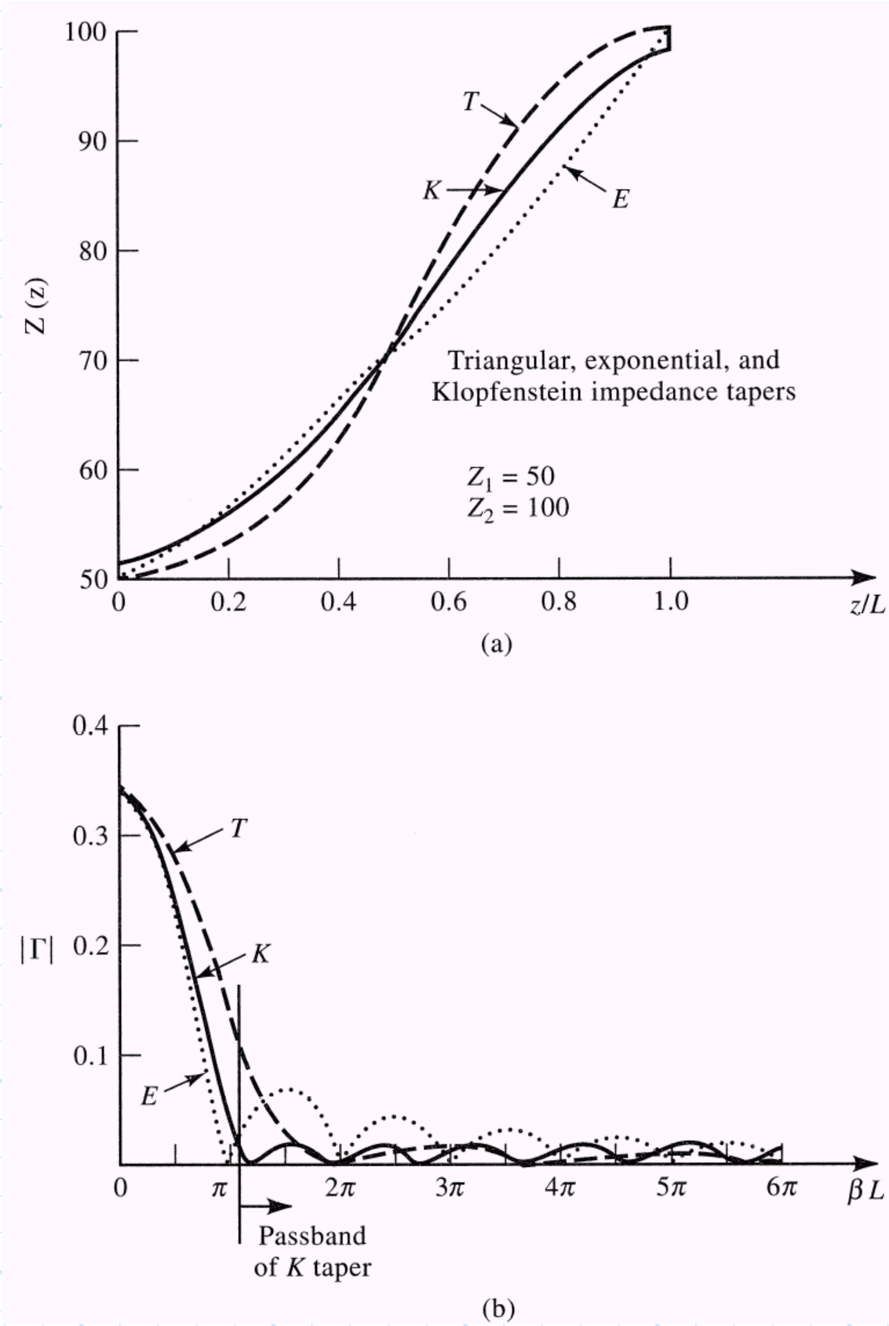


Figure 5.21 (p. 260)

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 $Z_1(z)$.