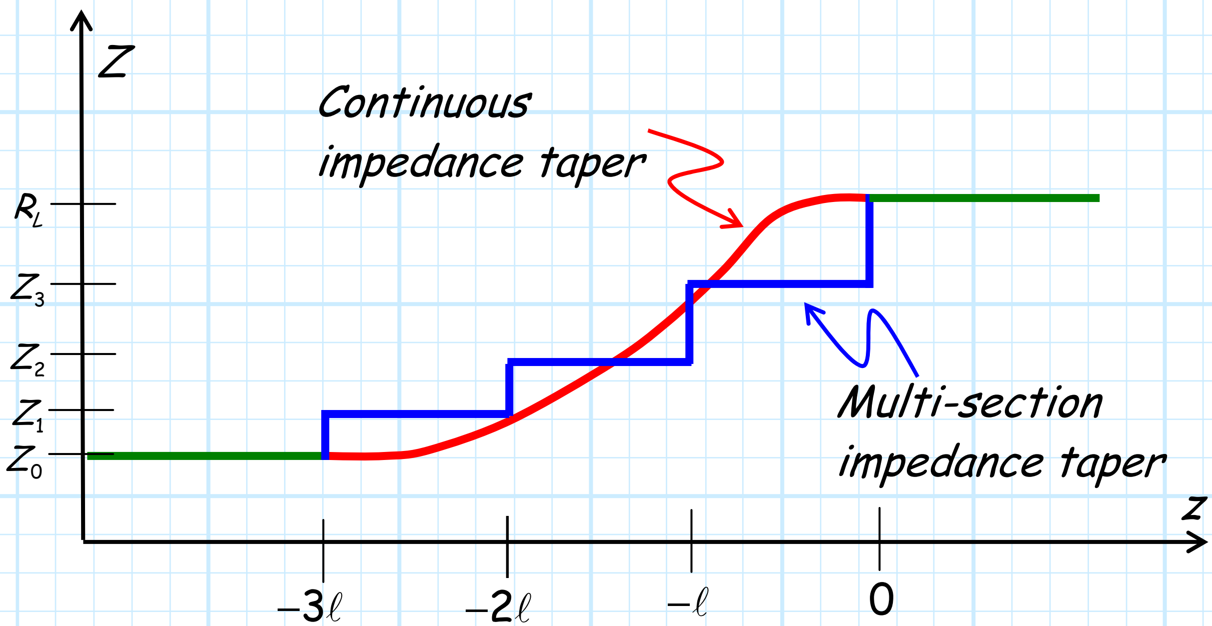
Tapered Lines

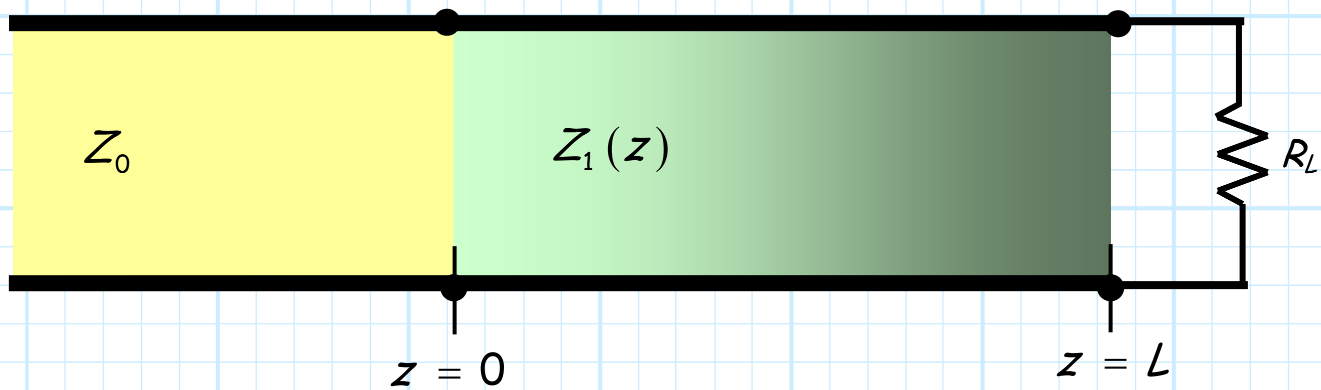
Note **all** our multi-section transformer designs have involved a **monotonic** change in characteristic impedance, from Z_0 to R_L (e.g., $Z_0 < Z_1 < Z_2 < Z_3 < \cdots < R_L$).

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**.



Just be glad your name is not Klopfenstein

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 $Z_1(z=L) = R_L$.

A longer taper increases bandwidth

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.

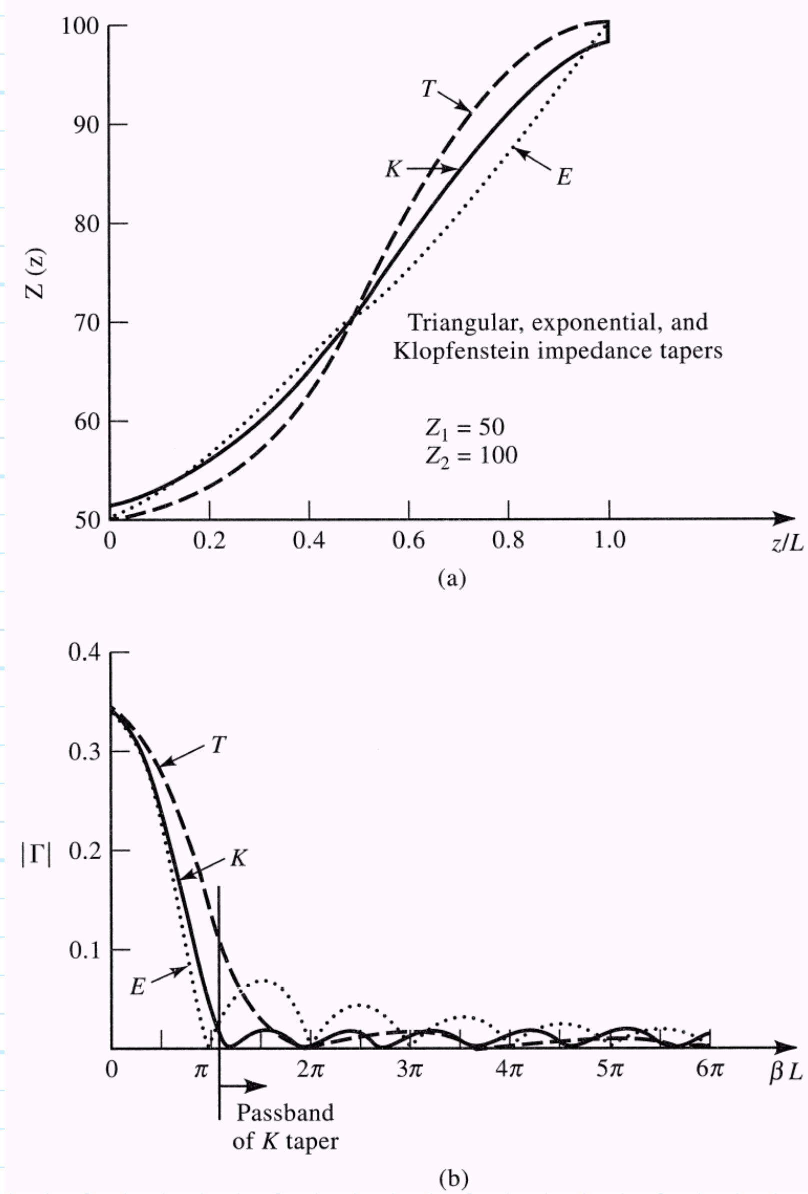


Figure 5.21 (p. 260)
Solution to Example 5.8. (a) Impedance variations for the triangular, exponential, and Klopfenstein tapers. (b) Resulting reflection coefficient magnitude versus frequency for the tapers of (a).

Tapers: easily created in microstrip or stripline

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 $Z_1(z)$.