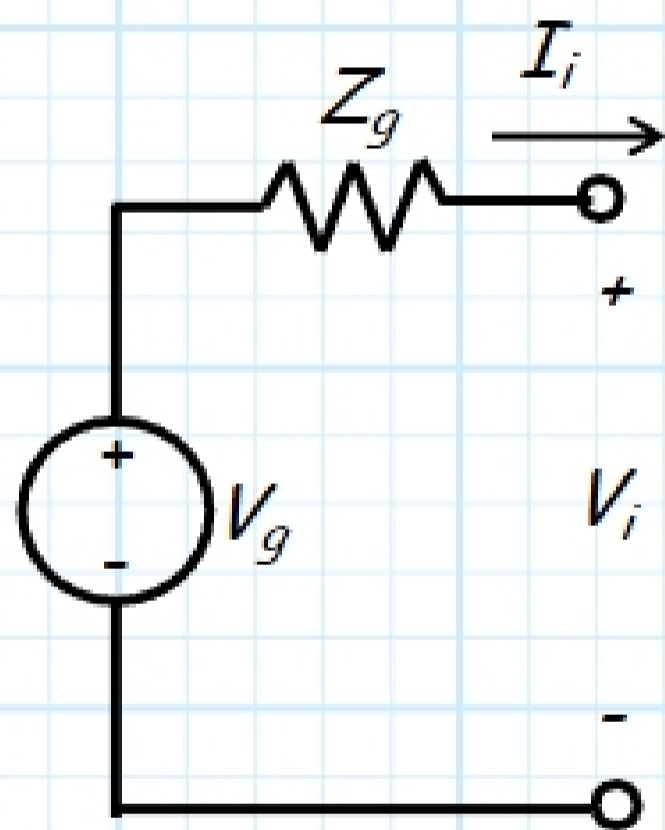


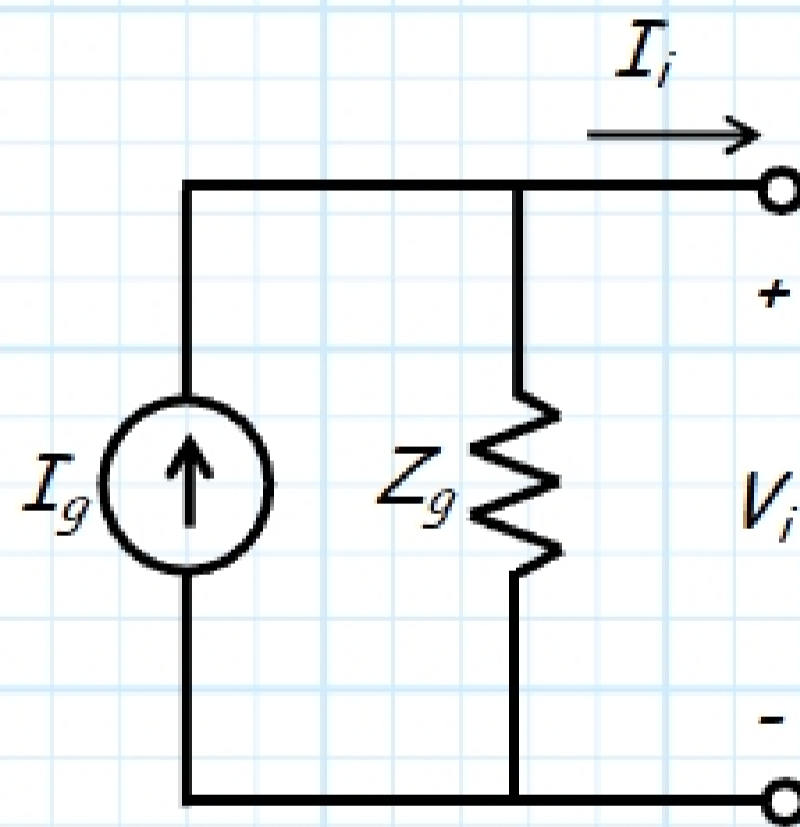
# A Transmission Line Connecting Source & Load

We can think of a transmission line as a conduit that allows **power** to flow from an **output** of one device/network to an **input** of another.

To simplify our analysis, we can model the **input** of the device **receiving** the power with its input impedance (e.g.,  $Z_L$ ), while we can model the device **output delivering** the power with its Thevenin's or Norton's equivalent circuit.

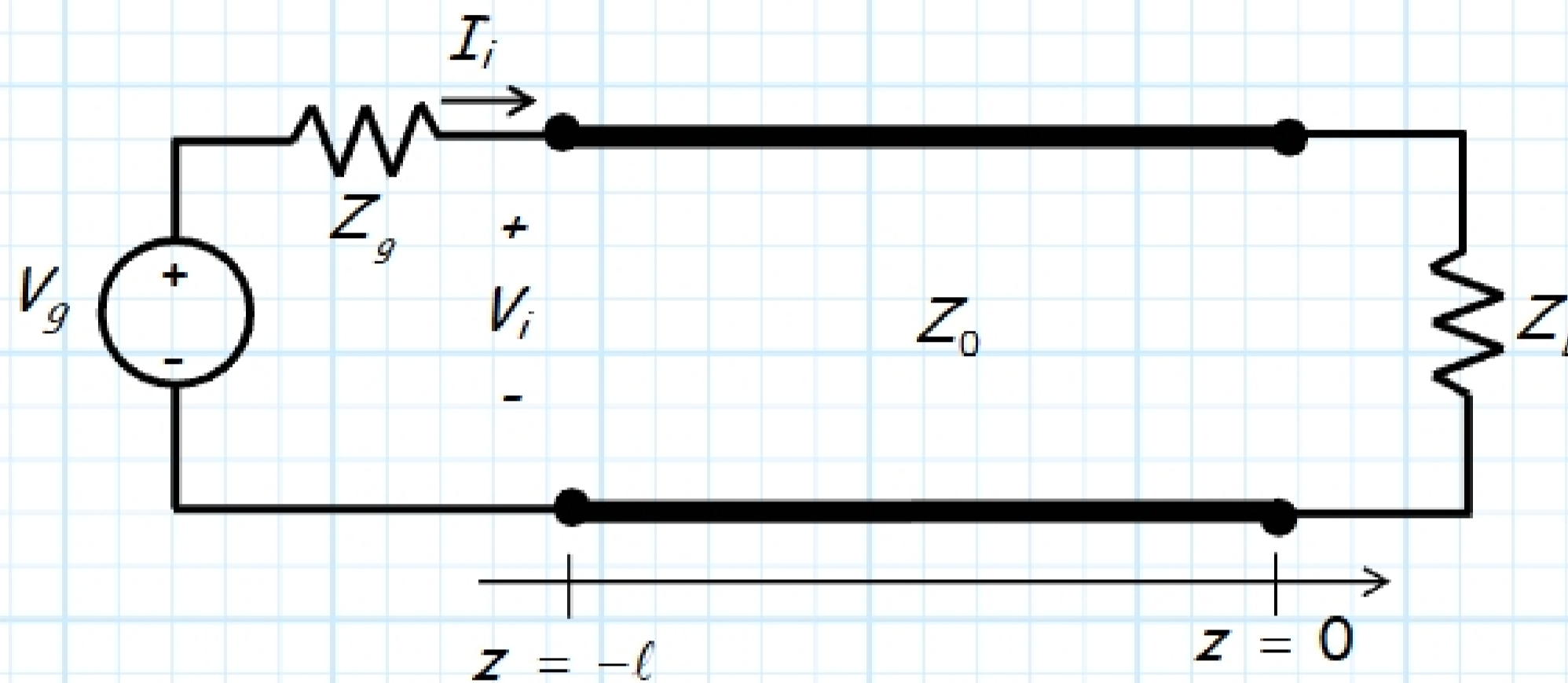


$$V_g = V_i + Z_g I_i$$



$$I_g = \frac{V_i}{Z_g} + I_i$$

Typically, the power source is modeled with its **Thevenin's** equivalent; however, we will find that the **Norton's** equivalent circuit is useful if we express the remainder of the circuit in terms of its **admittance** values (e.g.,  $Y_0, Y_L, Y(z)$ ).



**Recall** from the telegrapher's equations that the current and voltage along the transmission line are:

$$V(z) = V_0^+ e^{-j\beta z} + V_0^- e^{+j\beta z}$$

$$I(z) = \frac{V_0^+}{Z_0} e^{-j\beta z} - \frac{V_0^-}{Z_0} e^{+j\beta z}$$

At  $z = 0$ , we enforced the **boundary condition** resulting from Ohm's Law:

$$Z_L = \frac{V_L}{I_L} = \frac{V(z=0)}{I(z=0)} = \frac{(V_0^+ + V_0^-)}{\left(\frac{V_0^+}{Z_0} - \frac{V_0^-}{Z_0}\right)}$$

Which resulted in:

$$\frac{V_0^-}{V_0^+} = \frac{Z_L - Z_0}{Z_L + Z_0} \doteq \Gamma_L$$

So therefore:

$$V(z) = V_0^+ \left[ e^{-j\beta z} + \Gamma_L e^{+j\beta z} \right]$$

$$I(z) = \frac{V_0^+}{Z_0} \left[ e^{-j\beta z} - \Gamma_L e^{+j\beta z} \right]$$

We are left with the **question**: just what is the **value** of complex constant  $V_0^+$ ?!?

**This constant depends on the signal source!** To determine its exact **value**, we must now apply **boundary conditions** at  $z = -\ell$ .

We know that at the **beginning** of the transmission line:

$$V(z = -\ell) = V_0^+ \left[ e^{+j\beta\ell} + \Gamma_L e^{-j\beta\ell} \right]$$

$$I(z = -\ell) = \frac{V_0^+}{Z_0} \left[ e^{+j\beta\ell} - \Gamma_L e^{-j\beta\ell} \right]$$

Likewise, we know that the **source** must satisfy:

$$V_g = V_i + Z_g I_i$$