EXAMPLE 4.8 MAKING SIMPLIFYING ASSUMPTIONS

Sometimes, there are a few special cases of interest that can be solved analytically by making appropriate simplifying assumptions. The circuit in Figure 4.19 is one such example. Here for variety, we will solve the circuit by a direct application of KVL and KCL. KVL around the path containing the voltage sources and the diodes yields

$$-2E + v_{D1} - v_{D2} = 0 \tag{4.28}$$

and KCL at the junction of the two diodes gives

$$i_{D1} + i_{D2} = I_A. \tag{4.29}$$

These two equations, together with the equations for the diodes of the form of Equation 4.1, can be solved for the diode currents, assuming identical diodes.

Now, if we assume that the diode voltages are always positive enough to make the -1 term in the diode equation negligible (for Equation 4.1, true within less than one percent for all v_D larger than 125 mV), then i_{D1} becomes

$$i_{D1} = \frac{I_A}{1 + e^{-2E/V_{TH}}}. \tag{4.30}$$

We can obtain this equation by following these steps. First, substitute in Equation 4.28 expressions for v_{D1} and v_{D2} in terms of i_{D1} and i_{D2} derived from the diode equations (neglecting the -1 term). Second, obtain i_{D2} in terms of i_{D1} from this equation, substitute in Equation 4.29, and simplify to get Equation 4.30.

The diode current is thus a hyperbolic tangent function of the voltage E, except for an offset of $I_A/2$.

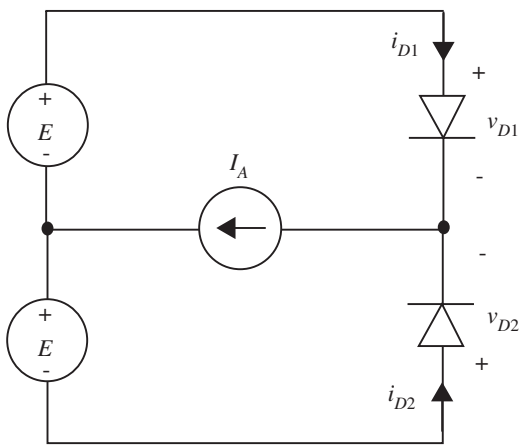

FIGURE 4.19 Hyperbolic tangent generator.