EXAMPLE 4.5 NODE METHOD This example uses the device shown in Figure 4.5. Recall that this device is characterized by the following device equation:

$$i_D = 0.1v_D^2 \quad \text{for} \quad v_D \geq 0, \tag{4.17}$$

i_D is given to be 0 for $v_D < 0$.

Referring to the series connected nonlinear devices in Figure 4.14, determine i_D, v_1, and v_2, given that $V = 2$ V.

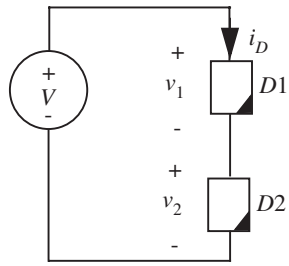

FIGURE 4.14 Nonlinear devices connected in series.

We will use the node method to solve this problem. We first select a ground node and label node voltages as shown in Figure 4.15. We have one unknown node voltage v_2.

Next, we write KCL for the node with the unknown node voltage. Recall that the KCL equations in the node method are written directly in terms of the node voltages. Accordingly,

$$0.1v_2^2 = 0.1(V - v_2)^2.$$

The term on the left-hand side is the current through device $D2$. Similarly, the term on the right-hand side is the current through device $D1$.

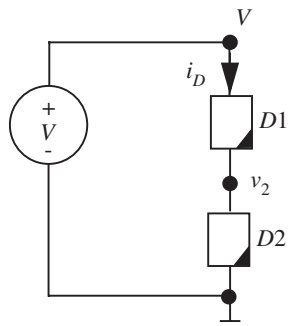

FIGURE 4.15 Circuit with node voltages labeled.

Solving, we get

$$v_2 = \frac{V}{2}.$$

Given that $V = 2$V, we get $v_2 = 1$V. We now obtain the remaining voltages and currents by applying KVL and the relevant device laws. Thus,

$$v_1 = V - v_2 = 1 \text{ V}$$

and

$$i_D = 0.1v_2^2 = 0.1 \text{ A}.$$

Notice that we could have also solved the circuit intuitively by realizing that the same current flows through two identical nonlinear devices. Thus, the same voltage must drop across both. In other words,

$$v_1 = v_2.$$

Furthermore, by KVL

$$2 \text{ V} = v_1 + v_2.$$

Or, $v_1 = v_2 = 1$ V.