EXAMPLE 2.33 VOLTAGE-CONTROLLED RESISTOR Thus far we have dealt with resistors that have a fixed resistance. However, like dependent sources, we can also have resistors whose values depend on other parameters. As an example, Figure 2.71 depicts a voltage-controlled resistor whose resistance R_X is a function of v_I.

Let us suppose we are interested in determining v_O as a function of v_I for

$$R_X = f(v_I) = R_o v_I$$

where R_o is some known constant. Let $R_o = 5$ kΩ/V.

First, R_1 and R_2 form a simple voltage divider, and since $R_1 = R_2$, we have $v_I = V/2$. Second, R_L and R_X also form a voltage divider. Therefore,

$$\begin{aligned} v_O &= V\frac{R_X}{R_L + R_X} \\ &= V\frac{R_o v_I}{R_L + R_o v_I} \\ &= V\frac{5\ \text{k}\Omega/v_I}{10\ \text{k}\Omega + 5\ \text{k}\Omega/v_I} \\ &= V\frac{v_I}{2 + v_I} \\ &= V\frac{\frac{V}{2}}{2 + \frac{V}{2}} \\ &= \frac{V^2}{4 + V}. \end{aligned}$$

Substituting $V = 5$ V, we find that $v_O = 25/9$ V.

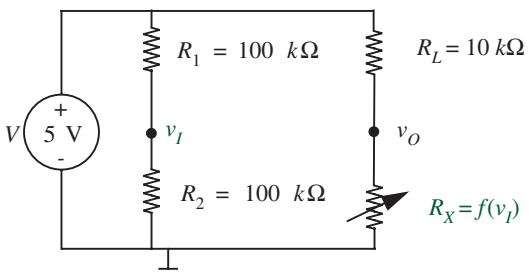

FIGURE 2.71 Circuit with voltage-dependent resistor.