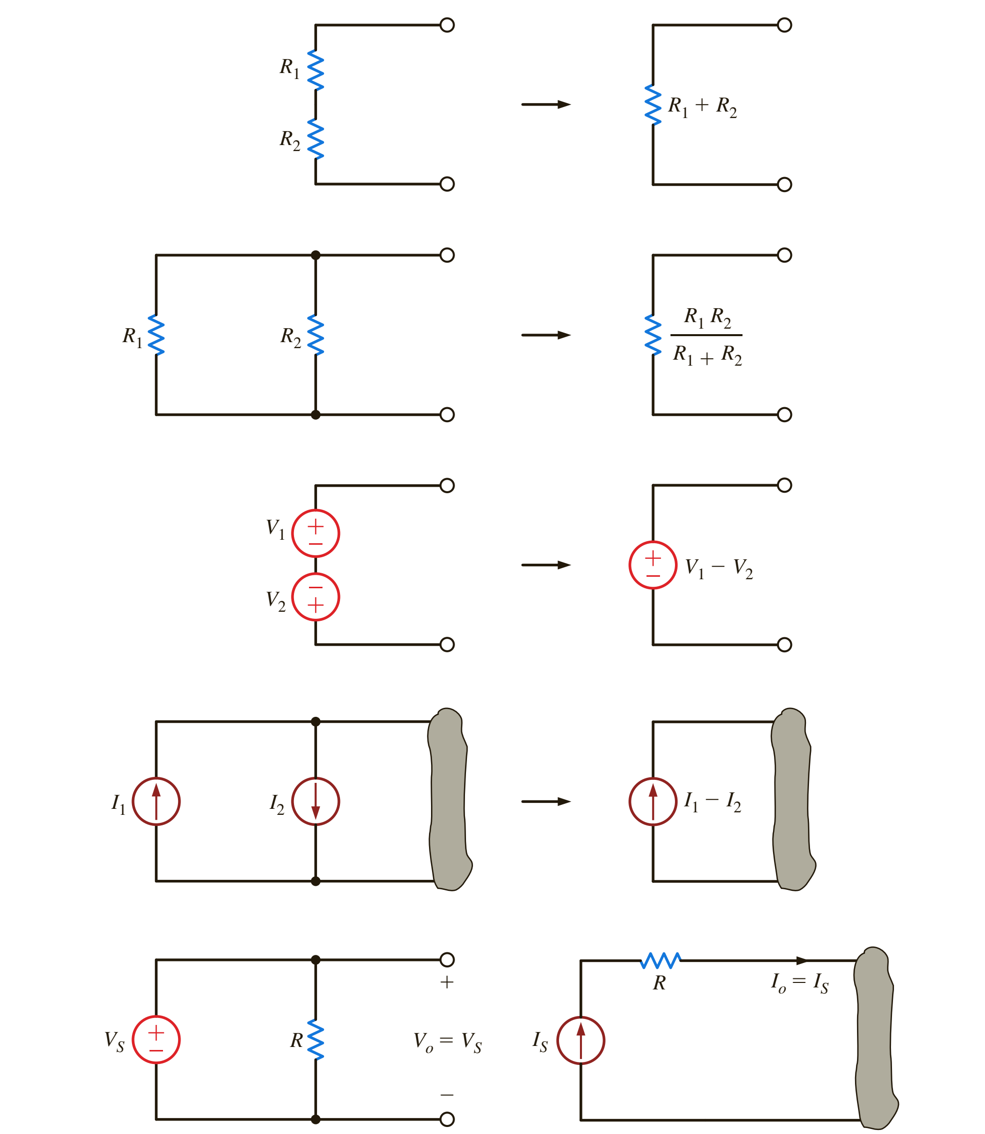
5.1 Introduction

Before introducing additional analysis techniques, let us review some of the topics we have used either explicitly or implicitly in our analyses thus far.

EQUIVALENCE Table 5.1 is a short compendium of some of the equivalent circuits that have been employed in our analyses. This listing serves as a quick review as we begin to look at other techniques that can be used to find a specific voltage or current somewhere in a network and provide additional insight into the network's operation. In addition to the forms listed in the table, it is important to note that a series connection of current sources or a parallel connection of voltage sources is forbidden unless the sources are pointing in the same direction and have exactly the same values.

LINEARITY All the circuits we have analyzed thus far have been linear circuits, which are described by a set of linear algebraic equations. Most of the circuits we will analyze in the remainder of the book will also be linear circuits, and any deviation from this type of network will be specifically identified as such.

TABLE 5.1 Equivalent circuit forms



Linearity requires both additivity and homogeneity (scaling). It can be shown that the circuits that we are examining satisfy this important property. The following example illustrates one way in which this property can be used.

EXAMPLE 5.1

For the circuit shown in Fig. 5.1, we wish to determine the output voltage V_{out}. However, rather than approach the problem in a straightforward manner and calculate I_o, then I_1, then I_2, and so on, we will use linearity and simply assume that the output voltage is $V_{out} = 1$ V. This assumption will yield a value for the source voltage. We will then use the actual value of the source voltage and linearity to compute the actual value of V_{out}.

SOLUTION

If we assume that $V_{out} = V_2 = 1$ V, then

$$I_2 = \frac{V_2}{2\text{k}} = 0.5 \text{ mA}$$

V_1 can then be calculated as

$$\begin{aligned} V_1 &= 4\text{k}I_2 + V_2 \\ &= 3 \text{ V} \end{aligned}$$

Hence,

$$I_1 = \frac{V_1}{3\text{k}} = 1\text{mA}$$

Now, applying KCL,

$$I_o = I_1 + I_2 = 1.5 \text{ mA}$$

Then

$$\begin{aligned} V_o &= 2\text{k}I_o + V_1 \\ &= 6 \text{ V} \end{aligned}$$

Therefore, the assumption that $V_{out} = 1$ V produced a source voltage of 6 V. However, since the actual source voltage is 12 V, the actual output voltage is 1 V(12/6) = 2 V.

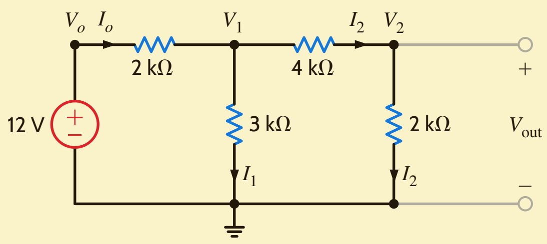


Figure 5.1 Circuit used in Example 5.1.

LEARNING ASSESSMENTS

E5.1 Use linearity and the assumption that $I_o = 1$ mA to compute the correct current I_o in the circuit in Fig. E5.1 if $I = 6$ mA.

ANSWER: $I_o = 3$ mA.

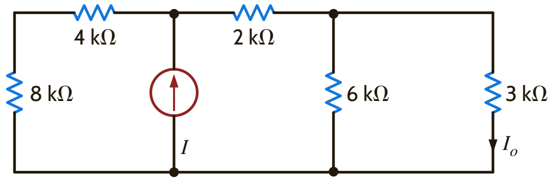


Figure E5.1