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P 5.2-1 The circuit shown in Figure P 5.2-1a has been divided into two parts. The circuit shown in Figure P 5.2-1b was obtained by simplifying the part to the right of the terminals using source transformations. The part of the circuit to the left of the terminals was not changed.

(a) Determine the values of $R_t$ and $v_t$ in Figure P 5.2-1b.

(b) Determine the values of the current $i$ and the voltage $v$ in Figure P 5.2-1b. The circuit in Figure P 5.2-1b is equivalent to the circuit in Figure P 5.2-1a. Consequently, the current $i$ and the voltage $v$ in Figure P 5.2-1b have the same values as do the current $i$ and the voltage $v$ in Figure P 5.2-1b.

(c) Determine the value of the current $i_a$ in Figure P 5.2-1a.

P 5.2-3 Find $v_o$ using source transformations if $i = 5/2$ A in the circuit shown in Figure P 5.2-3.

*Hint:* Reduce the circuit to a single mesh that contains the voltage source labeled $v_o$.

*Answer:* $v_o = 28$ V

P 5.2-6 Use source transformations to find the value of the voltage $v_a$ in Figure P 5.2-6.
**P 5.3-6** Use superposition to find the value of the current $i$ in Figure P 5.3-6.

*Answer:* $i = 3.5$ mA

![Figure P5.3-6](image)

**P 5.3-9** The input to the circuit shown in Figure P 5.3-9 is the voltage source voltage, $v_s$. The output is the voltage $v_o$. The current source current, $i_a$, is used to adjust the relationship between the input and output. Design the circuit so that input and output are related by the equation, $v_o = 2v_s + 9$.

*Hint:* Determine the required values of $A$ and $i_a$.

![Figure P 5.3-9](image)

**P 5.3-13** The input to the circuit shown in P 5.3-13 is the current $i_1$, the output is the voltage $v_o$. The current $i_2$ is used to adjust the relationship between the input and output. Determine values of the current $i_2$ and the resistance, $R$, that cause the output to be related to the input by the equation: $v_o = -0.5i_1 + 4$

![Figure P 5.3-13](image)
P 5.4-5  Find the Thévenin equivalent circuit for the circuit shown in Figure P 5.4-5.

*Answer:* $v_{oc} = -2 \, \text{V}$ and $R_t = -8/3 \, \Omega$

Figure P 5.4-4

P 5.4-12  The circuit shown in Figure P 5.4-12 contains an adjustable resistor. The resistance $R$ can be set to any value in the range $0 \leq R \leq 100 \, \text{k}\Omega$.

(a) Determine the maximum value of the current $i_a$ that can be obtained by adjusting $R$. Determine the corresponding value of $R$.

(b) Determine the maximum value of the voltage $v_a$ that can be obtained by adjusting $R$. Determine the corresponding value of $R$.

(c) Determine the maximum value of the power supplied to the adjustable resistor that can be obtained by adjusting $R$. Determine the corresponding value of $R$.

Figure P 5.4-12
P 5.4-14  The circuit shown in Figure P 5.4-14 contains an unspecified resistance, \( R \). Determine the value of \( R \) in each of the following two ways.

(a) Write and solve mesh equations.
(b) Replace the part of the circuit connected to the resistor \( R \) by a Thévenin equivalent circuit. Analyze the resulting circuit.

![Figure P 5.4-14](image)

P 5.4-16  An ideal voltmeter is modeled as an open circuit. A more realistic model of a voltmeter is a large resistance. Figure P 5.4-16a shows a circuit with a voltmeter that measures the voltage \( v_m \). In Figure P 5.4-16b the voltmeter is replaced by the model of an ideal voltmeter, an open circuit. The voltmeter measures \( v_{mi} \), the ideal value of \( v_m \).

As \( R_m \to \infty \), the voltmeter becomes an ideal voltmeter and \( v_m \to v_{mi} \). When \( R_m < \infty \), the voltmeter is not ideal and \( v_m > v_{mi} \). The difference between \( v_m \) and \( v_{mi} \) is a measurement error caused by the fact that the voltmeter is not ideal.

(a) Determine the value of \( v_{mi} \).
(b) Express the measurement error that occurs when \( R_m = 1000 \ \Omega \) as a percentage of \( v_{mi} \).
(c) Determine the minimum value of \( R_m \) required to ensure that the measurement error is smaller than 2 percent of \( v_{mi} \).

![Figure P 5.4-16](image)
**P 5.5-7** Determine the value of the resistance \( R \) in the circuit shown in Figure P 5.5-7 by each of the following methods:

(a) Replace the part of the circuit to the left of terminals a–b by its the Norton equivalent circuit. Use current division to determine the value of \( R \).

(b) Analyze the circuit shown Figure P 5.5-6 using mesh equations. Solve the mesh equations to determine the value of \( R \).

![Figure P 5.5-7](image)

**P5.5-8** Find the Norton equivalent circuit of this circuit:

![Circuit](image)

**P 5.5-11** Determine values of \( R_t \) and \( i_{sc} \) that cause the circuit shown in Figure P 5.5-11b to be the Norton equivalent circuit of the circuit in Figure P 5.5-11a.

**Answer:** \( R_t = 3 \, \Omega \) and \( i_{sc} = -2 \, \text{A} \)
P 5.6-1 The circuit shown in Figure P 5.6-1 consists of two parts separated by a pair of terminals. Consider the part of the circuit to the left of the terminals. The open circuit voltage is $v_{oc} = 8V$, and the short circuit current is $i_{sc} = 2A$. Determine the values of

(a) The voltage source voltage, $v_s$, and the resistance $R_2$.

(b) The resistance $R$ that maximizes the power delivered to the resistor to the right of the terminals, and the corresponding maximum power.