Problem 3.64  Find the Thévenin equivalent circuit at terminals \((a,b)\) for the circuit in Fig. P3.64.

![Figure P3.64: Circuit for Problem 3.64.](image)

**Solution:**

\[
\frac{V}{3} + \frac{V}{6} = 3 \\
V = 6 \text{ V.}
\]

Voltage division gives

\[
V_{\text{Th}} = V_{\text{oc}} = \frac{V}{6} \times 4 = 4 \text{ V.}
\]

Suppressing the current source:

\[
R_{\text{Th}} = 3 + \frac{20}{9} = \frac{47}{9} = 5.2 \text{ Ω.}
\]

Thévenin equivalent circuit:

![Thévenin equivalent circuit](image)
**Problem 3.73** Find the Norton equivalent circuit at terminals \((a, b)\) for the circuit in Fig. P3.73.

![Circuit](image)

**Figure P3.73:** Circuit for Problem 3.73.

**Solution:** The circuit contains no independent sources. Hence,

\[ V_{Th} = 0. \]

To determine \(R_{Th}\), we add an external voltage source \(V_{ex}\) and proceed to find \(I_{ex}\).

\[
0.1I_1 + 0.2(I_1 - I_2) - 0.2I_0 = 0 \\
0.2I_0 + 0.2(I_2 - I_1) + 0.2I_2 + 0.25(I_2 - I_3) = 0 \\
0.25(I_3 - I_2) + V_{ex} = 0
\]

Additionally, \(I_0 = I_1\).

Solution is:

\[
I_1 = -5V_{ex}, \quad I_2 = -2.5V_{ex}, \quad I_3 = -6.5V_{ex}, \\
I_{ex} = -I_3 = 6.5V_{ex} \\
R_{Th} = \frac{V_{ex}}{I_{ex}} = \frac{1}{6.5} = 0.15 \, \Omega
\]

Hence,
Problem 3.81 What value of the load resistor $R_L$ will extract the maximum amount of power from the circuit in Fig. P3.81, and how much power will that be?

![Circuit for Problem 3.81.](image)

**Solution:** We start by obtaining the Thévenin equivalent circuit at terminals $(a,b)$, as if $R_L$ were not there. We first find $V_{oc}$:

\[
\frac{V}{6} - 3 + \frac{V}{12} = 0
\]

\[V = 12 \text{ V}.
\]

Hence,

![Voltage division gives:](image)

\[V_{Th} = V_{oc} = \left(\frac{8}{4+8}\right) \times 12 = 8 \text{ V}.
\]

Next, we suppress the current source to find $R_{Th}$:

![Simplification leads to:](image)

\[R_{Th} = 10.44 \text{ Ω}.
\]

Equivalent circuit:

![For maximum power transfer to $R_L$,](image)

\[R_L = R_{Th} = 10.44 \text{ Ω} \]

\[I = \frac{8}{2 \times 10.44} = 0.38 \text{ A} \]

\[P_{max} = I^2 R_L = (0.38)^2 \times 10.44 = 1.53 \text{ W}.
\]
Problem 3.83  Determine the maximum power that can be extracted by the load resistor from the circuit in Fig. P3.83.

![Circuit for Problem 3.83.](image)

**Solution:** To find the Thévenin equivalent circuit, we start by determining $V_{Th} = V_{oc}$.

Voltage division:

$$V_1 = \frac{15}{(3+6)k} \times 6k = 10 \text{ V}$$

$$I_x = \frac{V_1}{6k} = \frac{10}{6} \text{ mA}.$$  

The dependent voltage source is:

$$2000I_x = 2 \times \frac{10}{6} \times 10^3 \times 10^{-3} = \frac{20}{6} \text{ V}.$$  

With $(a,b)$ an open circuit, no current flows through the 4-kΩ resistor. Hence, there is no voltage drop across it.

$$V_{Th} = V_{oc} = V_1 - 2000I_x = 10 - \frac{20}{6} = \frac{40}{6} = 6.67 \text{ V}.$$  

Next, we find $I_{sc}$:

$$-15 + 3kI_1 + 6k(I_1 - I_2) = 0$$

$$6k(I_2 - I_1) + 4kI_2 + 2000I_x = 0$$

Also,

$$I_x = I_1 - I_2$$

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Solution yields:

\[ I_1 = 2.5 \text{ mA}, \quad I_2 = 1.25 \text{ mA}. \]
\[ I_{sc} = I_2 = 1.25 \text{ mA}. \]
\[ R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{6.67}{1.25 \times 10^{-3}} = 5.33 \text{ k}\Omega. \]

Hence, \( R_L = 5.33 \text{ k}\Omega \) extracts maximum power.

\[ \begin{align*}
I &= \frac{6.67}{2 \times 5.33} = 0.625 \text{ mA} \\
P_{\text{max}} &= I^2R_L = (0.625 \times 10^{-3})^2 \times 5.33 \times 10^3 = 2.09 \text{ (mW)}. 
\end{align*} \]
**Problem 3.87**  Determine the maximum power extractable from the circuit in Fig. P3.87 by the load resistor $R_L$.

![Circuit for Problem 3.87](image)

**Figure P3.87:** Circuit for Problem 3.87.

**Solution:** The circuit has no independent sources. Hence,

$$V_{Th} = 0.$$  

Consequently, $R_L$ cannot extract any power from the circuit.