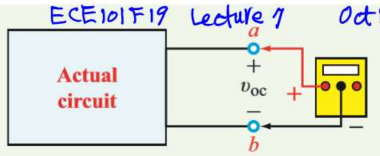
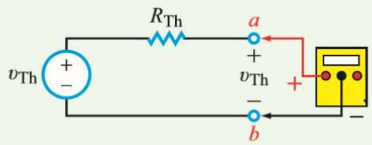
ECE101F19 Lecture 7 Oct 17, 2019



(a) Measuring v_{oc} on actual circuit



(b) Measuring v_{Th} of equivalent circuit

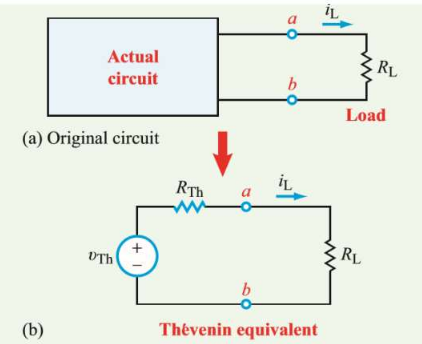
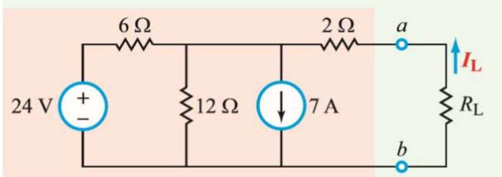
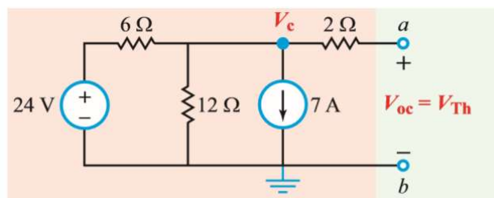


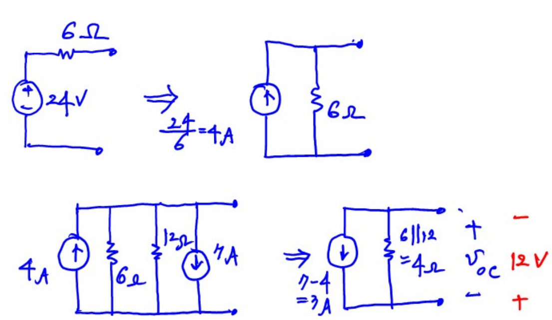
Figure 3-20: A circuit can be represented in terms of a Thévenin equivalent comprising a voltage source v_{Th} in series with a resistance R_{Th}.



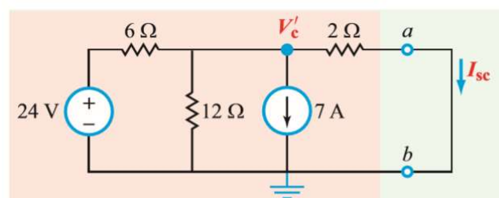
(a) Original circuit



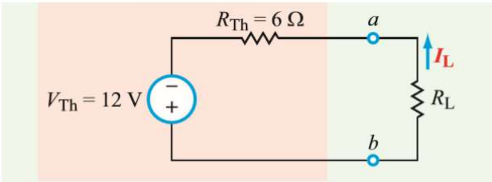
(b) Replacing R_L with open circuit



$v_{oc} = -3\times4 = -12V$



(c) Replacing R_L with short circuit



(d) Thévenin equivalent circuit

Exercise 3-11: Determine the Thévenin-equivalent circuit at terminals (a, b) in **Fig. E3.11**.

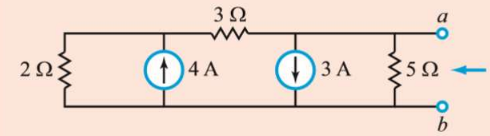


Figure E3.11

Equivalent-Resistance Method

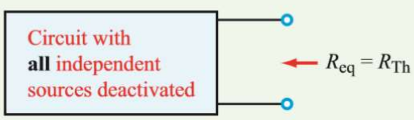
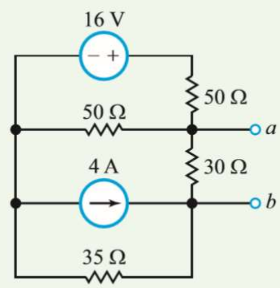
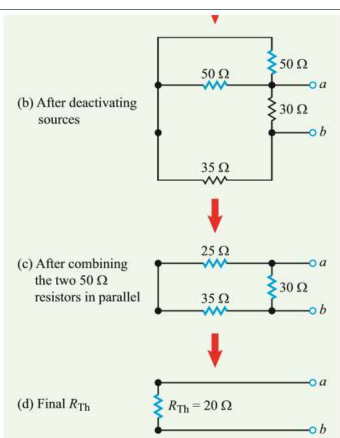
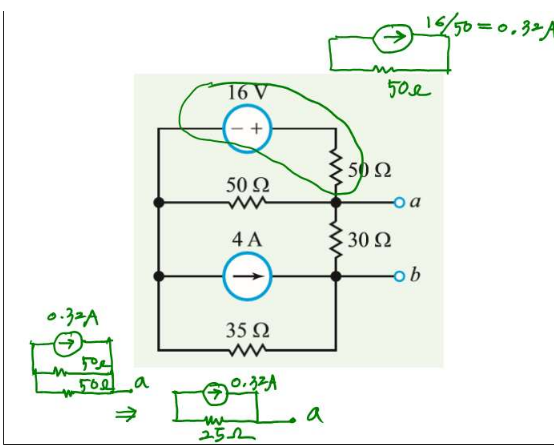


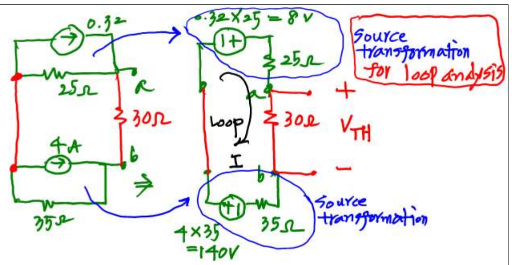
Figure 3-24: For a circuit that does not contain dependent sources, R_{Th} can be determined by deactivating all sources (replacing voltage sources with short circuits and current sources with open circuits) and then simplifying the circuit down to a single resistance R_{eq}.

(a) Original circuit





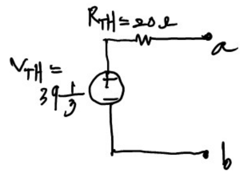




KVL: $-140-8+I(25+30+35)=0$

$I = \frac{148}{90}$

$V_{TH} = 30I = 30 \times \frac{148}{90} = 49\frac{1}{3}[V]$



External-Source Method

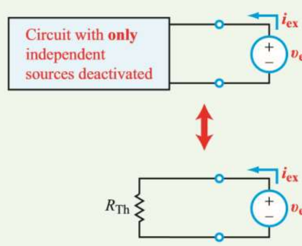
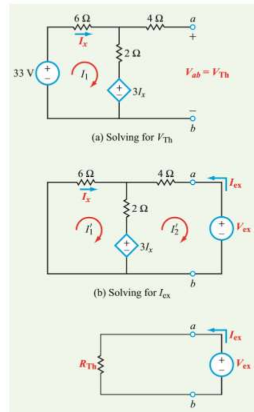


Figure 3-26: If a circuit contains both dependent and independent sources, R_{Th} can be determined by (a) deactivating only independent sources (by replacing independent voltage sources with short circuits and independent current sources with open circuits), (b) adding an external source υ_{ex}, and then (c) solving the circuit to determine i_{ex}. The solution is $R_{Th} = \upsilon_{ex}/i_{ex}$.



(a) Solving for V_{Th}

(b) Solving for I_{ex}

(c) Equivalent circuit for calculating R_{Th}

Solution: The KVL equation for mesh current I_1 in **Fig. 3-27(a)** is given by

$$-33 + 6I_1 + 2I_1 + 3I_x = 0.$$

Recognizing that $I_x = I_1$, solution of the preceding equation leads to

$$I_1 = 3\text{ A}.$$

Since there is no voltage drop across the 4 Ω resistor (because no current is flowing through it),

$$V_{Th} = V_{ab} = 2I_1 + 3I_x = 5I_1 = 15\text{ V}.$$

To find R_{Th} using the external-source method, we deactivate the 33 V voltage source and we add an external voltage source V_{ex}, as shown in **Fig. 3-27(b)**. Our task is to obtain an expression for I_{ex} in terms of V_{ex}. In **Fig. 3-27(b)** we have two mesh currents, which we have labeled I_1' and I_2'. Their equations are given by

$$6I_1' + 2(I_1' - I_2') + 3I_x = 0,$$
$$-3I_x + 2(I_2' - I_1') + 4I_2' + V_{ex} = 0.$$

After replacing I_x with I_1' and solving the two simultaneous equations, we obtain

$$I_1' = -\frac{1}{28}V_{ex},$$

and

$$I_2' = -\frac{11}{56}V_{ex}.$$

For the equivalent circuit shown in **Fig. 3-27(c)**,

$$R_{Th} = \frac{V_{ex}}{I_{ex}}.$$

In terms of our solution, $I_{ex} = -I_2'$. Hence,

$$R_{Th} = -\frac{V_{ex}}{I_2'} = \frac{56}{11}\ \Omega.$$

Table 3-1: **Properties of Thévenin/Norton analysis techniques.**

To Determine	Method	Can Circuit Contain Dependent Sources?	Relationship
υ_{Th}	Open-circuit υ	Yes	$\upsilon_{\text{Th}} = \upsilon_{\text{oc}}$
υ_{Th}	Short-circuit i (if R_{Th} is known)	Yes	$\upsilon_{\text{Th}} = R_{\text{Th}} i_{\text{sc}}$
R_{Th}	Open/short	Yes	$R_{\text{Th}} = \upsilon_{\text{oc}} / i_{\text{sc}}$
R_{Th}	Equivalent R	No	$R_{\text{Th}} = R_{\text{eq}}$
R_{Th}	External source	Yes	$R_{\text{Th}} = \upsilon_{\text{ex}} / i_{\text{ex}}$
$i_{\text{N}} = \upsilon_{\text{Th}} / R_{\text{Th}}$; $R_{\text{N}} = R_{\text{Th}}$			