Thévenin’s Theorem

Linear two-terminal circuit can be replaced by an equivalent circuit composed of a voltage source and a series resistor

\[ v_{Th} = v_{oc} \]

voltage across output with no load (open circuit)

\[ R_{Th} = R_{in} \]

Resistance at terminals with all independent circuit sources set to zero
Norton’s Theorem

Linear two-terminal circuit can be replaced by an equivalent circuit composed of a current source and parallel resistor.

\[ i_N = \frac{v_{Th}}{R_{Th}} \]

Current through output with short circuit.

\[ R_N = R_{Th} \]

Resistance at terminals with all circuit sources set to zero.
How Do We Find Thévenin/Norton Equivalent Circuits?

- **Method 1: Open circuit/Short circuit**
  1. Analyze circuit to find $v_{oc}$
  2. Analyze circuit to find $i_{sc}$

  $$v_{Th} = v_{oc}$$

  $$R_{Th} = \frac{v_{Th}}{i_{sc}}$$

**Note:** This method is applicable to “any circuit”, whether or not it contains dependent sources.

The circuit must include at least one (nonzero) independent source, otherwise $v_{Th} = i_{sc} = 0$!
How Do We Find Thévenin/Norton Equivalent Circuits?

**Method 2: Equivalent Resistance**

1. Analyze circuit to find either
   
   \[ v_{oc} \text{ or } i_{sc} \]

2. Deactivate all independent sources by replacing voltage sources with short circuits and current sources with open circuits.
3. Simplify circuit to find equivalent resistance

**Note:** This method does not apply to circuits that contain dependent sources.

Why does this method work for finding \( R_{Th} \)?
Method 3:

**External-Source Method**

Circuit with only independent sources deactivated

![Circuit diagram](image)

**Figure 3-22:** If a circuit contains both dependent and independent sources, $R_{Th}$ can be determined by (a) deactivating independent sources (only), (b) adding an external source $v_{ex}$, and then (c) solving the circuit to determine $i_{ex}$. The solution is $R_{Th} = v_{ex} / i_{ex}$.

This method **must** be used if the circuit contains no independent sources. Still need to find $v_{Th} = v_{oc}$. 


How Do We Find Thévenin/Norton Equivalent Circuits?