Friday, February 12, 2016

Node b: $\frac{V_b - V_a}{20} + \frac{V_b}{5} - 1 = 0$

(×20) $V_b - V_a + 4V_b - 20 = 0$

$-V_a + 5V_b = 20$ (2)

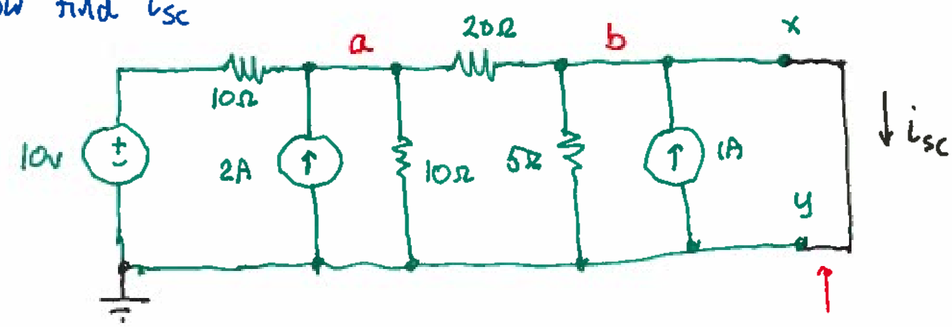
From (2), $V_a = 5V_b - 20$

Into (1) $5(5V_b - 20) - V_b = 60$

$24V_b = 160$

$\therefore \quad V_t = V_b = V_{oc} = 6.667\text{ v}$

Now find i_{sc}



General observation:
Note this changes the circuit. Usually must treat circuit as a whole new analysis problem.

Node b is again attached to the reference node, $V_b = 0$

Node a: $\frac{V_a - 10}{10} + \frac{V_a}{10} - 2 + \frac{V_a - V_b}{20} = 0$ ← $V_b = 0$

(×20) $2V_a - 20 + 2V_a - 40 + V_a = 0$

$5V_a = 60$, so $V_a = 12$ v

For node b, we know $V_b = 0$, but we write a node equation with unknown current i_{sc}.

Node b: $\frac{V_b - V_a}{20} + \frac{V_b}{5} - 1 + i_{sc} = 0$

5Ω resistor shorted out (no current)

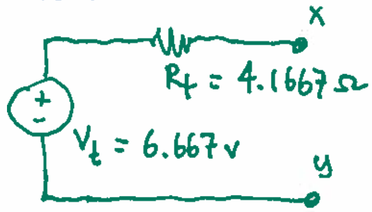
$-\frac{V_a}{20} - 1 + i_{sc} = 0$

$$i_{sc} = 1 + \frac{12}{20} = 1.6\ A$$

Therefore, $$R_t = \frac{V_t}{i_{sc}} = \frac{6.667}{1.6}$$

$$R_t = 4.1667\ \Omega$$

Thevenin equivalent



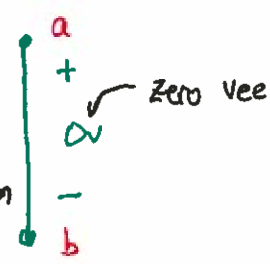
Shortcut method for finding Thevenin resistance

If a circuit has no dependent sources, then we may use an alternative method to find R_t by zeroing the sources.

We zero their values and use their "effective" resistance.

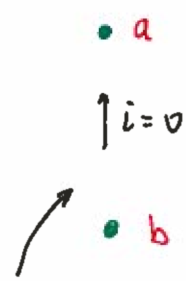
E.g.,

If we let $v = 0$, the source becomes a short circuit.



Effective resistance = $0\ \Omega$

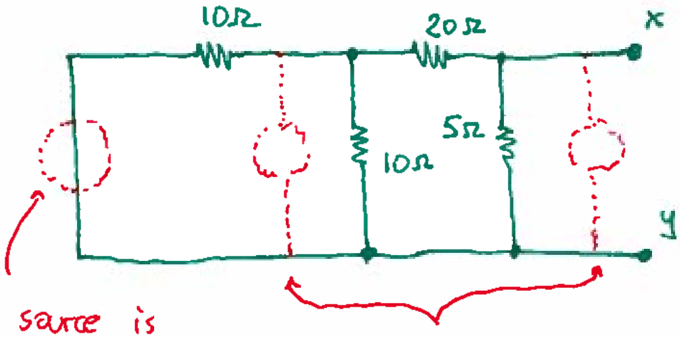
Let $i = 0$, then the source becomes an open circuit.



Effective resistance = $\infty\ \Omega$

Repeat Example #2

Use $V_t = 6.667\ v$. Solve for R_t by zeroing the sources.



Voltage source is a short circuit

The two current sources are open circuits

Series-parallel combination of resistors

$$R_t = [(10 /\!/ 10) + 20] /\!/ 5$$

in parallel with

$$= (5+20) /\!/ 5$$

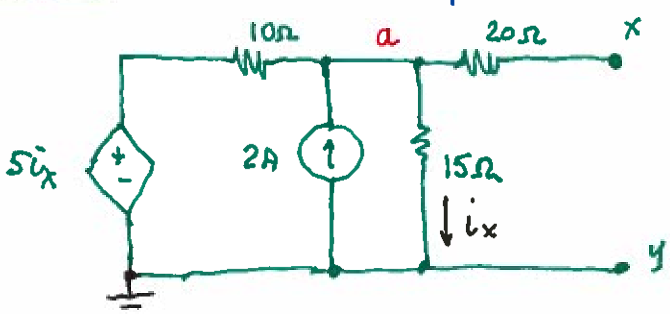
$$= \frac{25 \times 5}{25+5} = 4.1667\,\Omega$$

Thevenin equivalents with dependent sources

The above short-cut method cannot be used if a circuit has dependent sources.

Must determine i_{sc}, the $R_t = V_t / i_{sc}$

Example 1: Find Thevenin equivalent



First, find V_t. With the terminals x, y open-circuited, no current flows in 20Ω resistor, so $V_t = V_{oc} = V_a$.