Problem 1

Solution:

Known quantities:

The schematic of the circuit (see Figure P3.10).

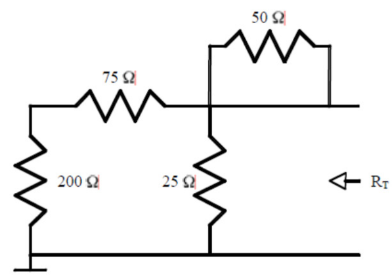
Find:

The Thévenin equivalent resistance seen by resistor R_5, the Thévenin (open-circuit) voltage and the Norton (short-circuit) current when R_5 is the load.

Analysis:

(1) Remove the load, leaving the load terminals open circuited, and the voltage sources. Redraw the circuit.

$$R_T = 25\ \Omega \,\|\, (75\ \Omega + 200\ \Omega) = 22.92\ \Omega$$



(2) Remove the load, leaving the load terminals open circuited. Redraw the circuit.

For node #1:

$$\frac{v_1}{200} + \frac{v_1 - v_2}{75} = 0.2$$

For node #2:

$$\frac{v_2 - v_1}{75} + \frac{v_2}{25} + \frac{v_2 - v_3}{50} + i_{10V} = 0$$

For node #3:

$$\frac{v_3 - v_2}{50} = i_{10V}$$

For the voltage source:

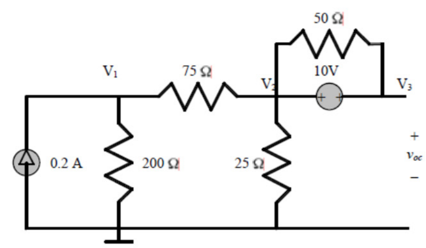
$$v_3 + 10 = v_2$$

Solving the system,

$v_1 = 13.33\text{ V}$, $v_2 = 3.33\text{ V}$ and $v_3 = -6.67\text{ V}$.

Therefore,

$v_{OC} = v_3 = -6.67\text{ V}$.



(3) Replace the load with a short circuit. Redraw the circuit.

For mesh (a):

$$i_a(50) = 10$$

For mesh (b):

$$i_b(300) - i_c(25) = 40$$

For mesh (c):

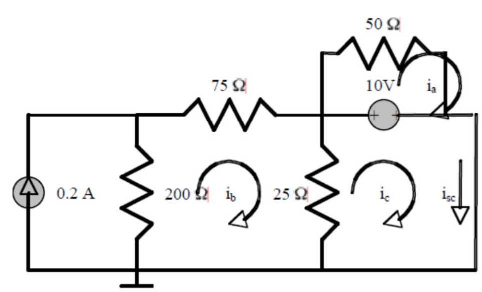
$$i_b(25) - i_c(25) = 10$$

Solving the system,

$i_a = 200\text{ mA}$, $i_b = 109\text{ mA}$ and $i_c = -291\text{ mA}$.

Therefore,

$i_{SC} = i_c = -291\text{ mA}$.

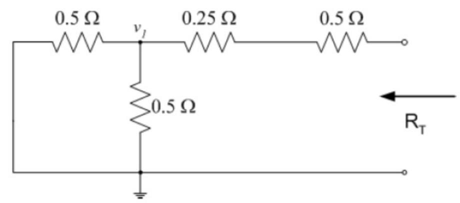


Problem 2

Solution:

Known quantities:

The schematic of the circuit (see Figure P3.23).



Find:

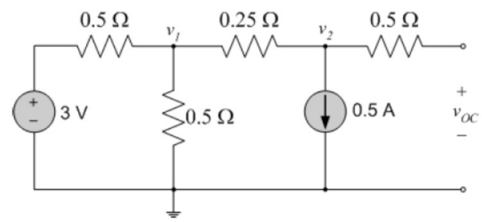
The Thévenin equivalent resistance seen by resistor R_5, the Thévenin (open-circuit) voltage and the Norton (short-circuit) current when R_5 is the load.

Analysis:

(1) Remove the load, leaving the load terminals open circuited, and the voltage sources. Redraw the circuit.

$$R_T = 0.5\ \Omega + 0.25\ \Omega + (0.5\ \Omega \,\|\, 0.5\ \Omega) = 1\ \Omega$$

(2) Remove the load, leaving the load terminals open circuited. Redraw the circuit.



For node #1:

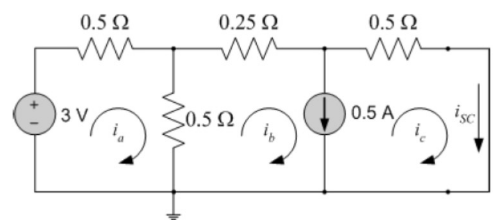
$$\frac{v_1 - 3}{0.5} + \frac{v_1}{0.5} + \frac{v_1 - v_2}{0.25} = 0$$

For node #2:

$$\frac{v_2 - v_1}{0.25} + 0.5 = 0$$

Solving the system,
$v_1 = 1.375$ V and $v_2 = 1.25$ V .
Therefore,
$v_{OC} = v_2 = 1.25$ V.

(3) Replace the load with a short circuit. Redraw the circuit.



For mesh (a):

$$i_a(0.5+0.5) - i_b(0.5) = 3$$

For meshes (b) and (c):

$$-i_a(0.5) + i_b(0.5+0.25) + i_c(0.5) = 0$$

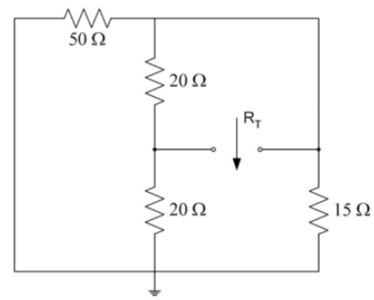
For the current source:

$$i_b - i_c = 0.5$$

Solving the system,
$i_a = 3.875$ A , $i_b = 1.75$ A and $i_c = 1.25$ A .
Therefore,
$i_{SC} = i_c = 1.25$ A .

Problem 3

Solution:



Known quantities:

The schematic of the circuit (see Figure P3.25).

Find:

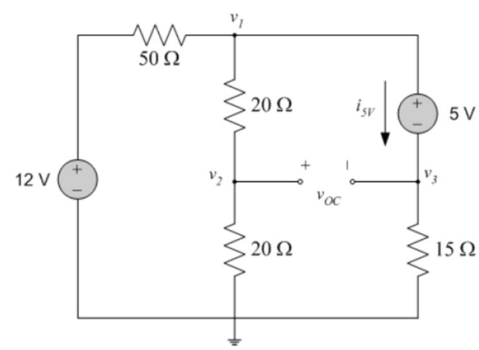
The Thévenin equivalent resistance seen by resistor R_4, the Thévenin (open-circuit) voltage and the Norton (short-circuit) current when R_4 is the load.

Analysis:

(1) Remove the load, leaving the load terminals open circuited, and the voltage sources. Redraw the circuit.

$$R_T = R_2 \parallel \left(R_3 + \left(R_1 \parallel R_5\right)\right) = 20\ \Omega \parallel \left(20\ \Omega + \left(50\ \Omega \parallel 15\ \Omega\right)\right) = 12.24\ \Omega$$

(2) Remove the load, leaving the load terminals open circuited. Redraw the circuit.



For node #1:

$$\frac{v_1 - 12}{50} + \frac{v_1 - v_2}{20} + i_{5V} = 0$$

For node #2:

$$\frac{v_2 - v_1}{20} + \frac{v_2}{20} = 0$$

For node #3:

$$\frac{v_3}{15} - i_{5V} = 0$$

For the 5-V voltage source:

$v_1 - v_3 = 5$

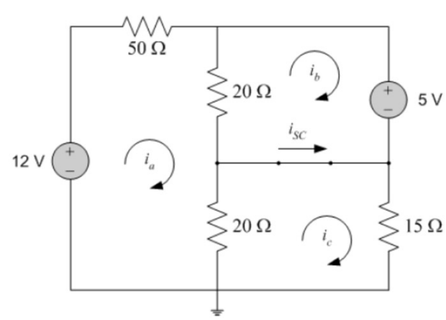
Solving the system,

$v_1 = 5.14\text{ V}$, $v_2 = 2.57\text{ V}$, $v_1 = 0.13\text{ V}$ and $i_{5V} = 8.95\text{ mA}$.

Therefore,

$v_{OC} = v_2 - v_3 = 2.44\text{ V}$.

(3) Replace the load with a short circuit. Redraw the circuit.



For mesh (a):

$$i_a(90) - i_b(20) - i_c(20) = 12$$

For mesh (b):

$$-i_a(20) + i_b(20) + 5 = 0$$

For mesh (c):

$$-i_a(20) + i_c(35) = 0$$

Solving the system,

$i_a = 119.5\text{ mA}$, $i_b = -130.5\text{ mA}$ and $i_c = 68.3\text{ mA}$.

Therefore,

$i_{SC} = i_c - i_b = 198.8\text{ mA}$.