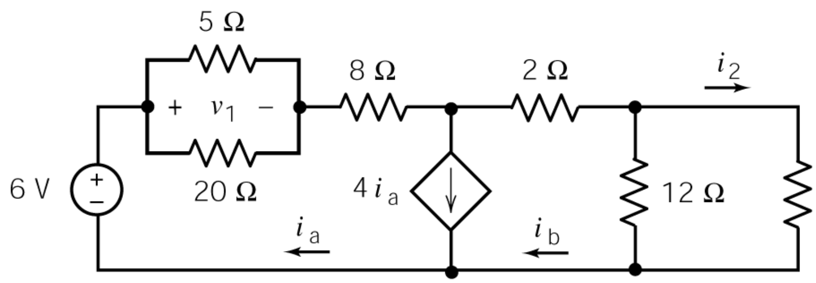
ES 250 First Midterm Practice Exam 2

1.

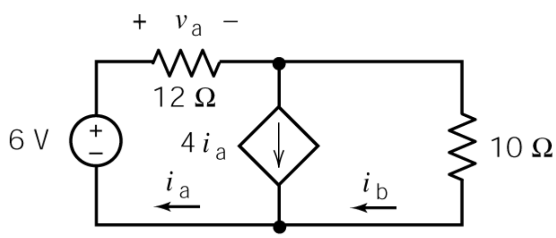


i_a = _−0.333__A, i_b = ___1____A, and

i_2 = __0.333__A,

v_1 = _−1.333__V

Use equivalent resistances to reduce the circuit to



From KCL $i_b = 4i_a + i_a \Rightarrow i_b = -3i_a$.

From KVL

$$12i_a + 10i_b - 6 = 0 \Rightarrow 12i_a + 10(-3i_a) = 6$$

So $i_a = -\frac{1}{3}$ A, $v_a = -4$ A and $i_b = 1$ A .

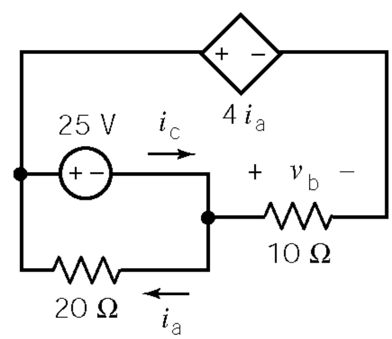
Returning our attention to the original circuit, notice that i_a and i_b were not changed when the circuit was reduced. Now $v_1 = (5 \| 20)i_a = (4)(-0.333) = -1.333$ V and $i_2 = \frac{12}{12+24} i_b = 0.333$ A .

2.

The current in the 20-Ω resistor is i_a = ____−1.25___A.

The voltage across the 10-Ω resistor is v_b = ____−30_____V.

The (independent) voltage source current is i_c = __−4.25____A.

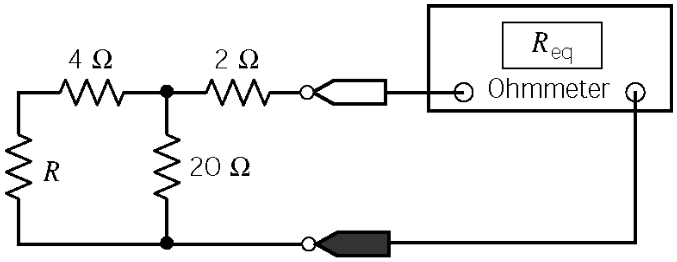


From Ohm's law $i_a = -\frac{25}{20} = -1.25$ A .

From KVL $4i_a - v_b + 20i_a = 0 \Rightarrow v_b = 24i_a = 24(-1.25) = -30$ V

From KCL $i_c = i_a + \frac{v_b}{10} = -1.25 + \frac{-30}{10} = -4.25$ A

3.



The Ohmmeter measures equivalent resistance.

a. To cause R_{eq} = 12 Ω, choose R = ___16__Ω.

b. If R = 14 Ω then R_{eq} = ___11.5____Ω.

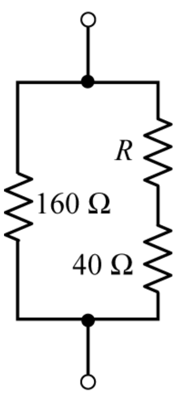
$R_{eq} = 2 + (20 \,||\, (4+R))$. When $R_{eq} = 12\ \Omega$ then

$$12 = 2 + (20 \,||\, (4+R)) \quad \Rightarrow \quad 10 = \frac{20(4+R)}{20+(4+R)} \quad \Rightarrow \quad 24 + R = 2(4+R) \quad \Rightarrow \quad R = 16\ \Omega$$

When $R = 14\ \Omega$ then

$$R_{eq} = 2 + (20 \,||\, (4+14)) = 2 + (20 \,||\, 18) = 2 + \frac{20(18)}{20+18} = 11.4736\ \Omega$$

4.



Consider this combination of resistors. Let R_p denote the equivalent resistance.

(a) Suppose 40 Ω ≤ R ≤ 400 Ω. Determine the corresponding range of values of R_p:

___53.33__ Ω ≤ R_p ≤ __117.33___ Ω

(b) Suppose instead R = 0 (a short circuit). Then R_p = ___32____ Ω

(c) Suppose instead $R = \infty$ (an open circuit). Then R_p = ___160___ Ω

(d) Suppose instead the equivalent resistance is R_p = 80 Ω. Then R = ___120___ Ω

When R = 40 Ω then $R_p = 160 \,||\, (40+40) = 160 \,||\, 80 = \frac{160(80)}{160+80} = \frac{160}{3} = 53.33\ \Omega$.

When R = 400 Ω then $R_p = 160 \,||\, (40+400) = 160 \,||\, 440 = \frac{160(440)}{160+440} = \frac{16(44)}{6} = 117.33\ \Omega$.

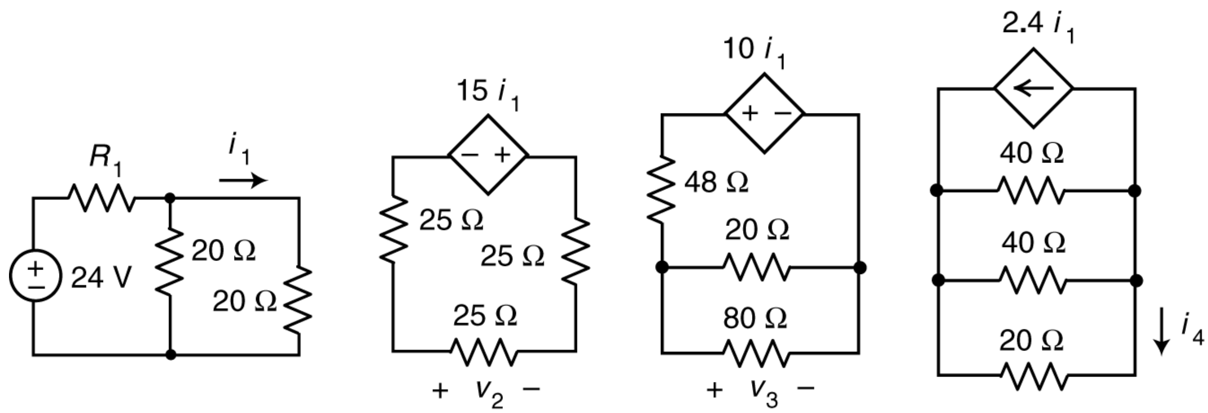
When R = 0 then $R_p = 160 \,||\, (0+40) = 160 \,||\, 40 = \frac{160(40)}{160+40} = \frac{16(4)}{2} = 32\ \Omega$.

When $R = \infty$ then $R_p = 160 \,||\, (\infty+40) = 160 \,||\, \infty = \frac{1}{\frac{1}{160}+\frac{1}{\infty}} = 160\ \Omega$.

When R_p = 80 Ω then

$$80 = 160 \,||\, (R+40) = \frac{160(R+40)}{160+R+40} \quad \Rightarrow \quad R + 200 = \frac{160}{80}(R+40) = 2R + 80 \quad \Rightarrow \quad R = 120\ \Omega.$$

5.



Here's a single circuit drawn in four parts for convenience. The four parts are connected by the dependent sources. Given that $i_1 = 0.8$ A, determine the values of R_1, v_2, v_3, and i_4.

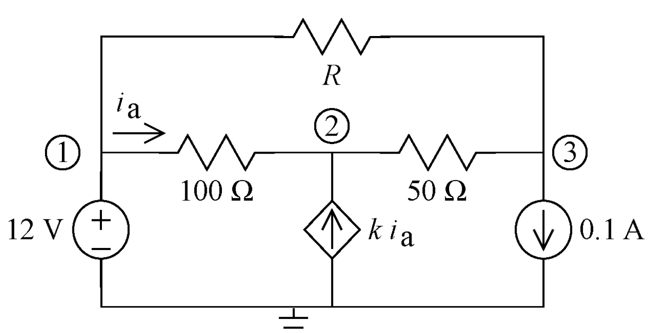
R_1 = ____5____Ω, v_2 = ____–4____V, v_3= ___2___V and i_4= __–0.96____A.

$$0.8 = \frac{1}{2}\left(\frac{24}{R_1 + 10}\right) \Rightarrow R_1 + 10 = \frac{12}{0.8} = 15 \Rightarrow R_1 = 5\ \Omega$$

$$v_2 = -\frac{1}{3}\left[15(0.8)\right] = -4\ \text{V},\ v_3 = \frac{20 \| 80}{48 + (20 \| 80)} 10(0.8) = \frac{16}{48+16} 8 = 2\ \text{V}$$

$$i_4 = -\frac{40 \| 40}{(40 \| 40) + 20} 2.4(0.8) = -\frac{1}{2}(1.92) = -0.96\ \text{A}$$

6.



Encircled numbers are node numbers. The corresponding node voltages are:

$v_1 = 12$ V, $v_2 = 10.5$ V and $v_3 = 6$ V

The value of the gain of the CCCS is k = ____5.00_____ A/A.

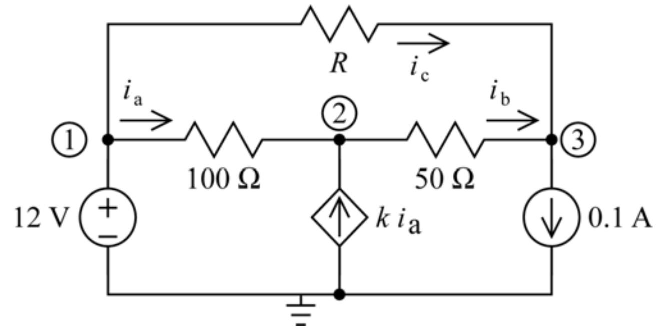
The resistance of the resistor at the top of the circuit is R = __600_____Ω. (Round to an integer.)

The power supplied by the independent (0.1 A) current source is ____–0.6___W.

$$i_a = \frac{12-10.5}{100} = 0.015 \text{ A}, \quad i_b = \frac{10.5-6}{50} = 0.09 \text{ A}$$

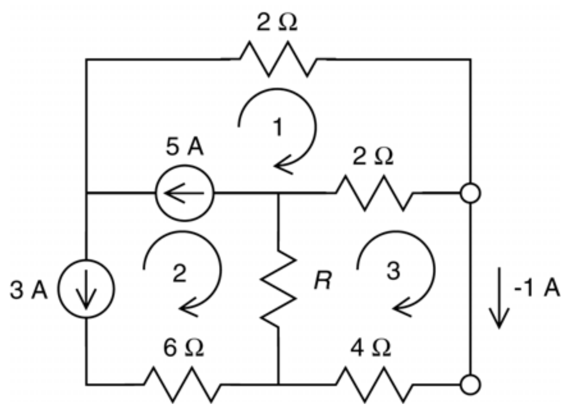
$$i_c + i_b = 0.1 \quad \Rightarrow \quad i_c = -0.09 + 0.1 = 0.01 \text{ A}$$

$$i_a + k\,i_a = i_b \quad \Rightarrow \quad k\,i_a = i_b - i_a = 0.09 - 0.015 = 0.075 \text{ A}$$



$$k = \frac{k\,i_a}{i_a} = \frac{0.075}{0.015} = 5 \text{ A/A}, \quad R = \frac{12-6}{i_c} = \frac{6}{0.01} = 600\ \Omega \text{ and the power is } -(6)(0.1) = -0.6 \text{ W}$$

7.



Let i_1, i_2 and i_3 denote the mesh currents in meshes 1, 2 and 3, respectively.

Determine the values of these mesh currents:

i_1 = ____2____A and i_2 = ____–3_____A

Determine the value of the resistance R:

R = _____5_______ Ω

$i_2 = -3$ A, $i_1 - i_2 = 5 \Rightarrow i_1 = 2$ A, $i_3 = -1$ A. The applying KVL to mesh 3 gives

$$2(i_3 - i_1) + 4i_3 + R(i_3 - i_2) = 0 \quad \Rightarrow \quad R = -\frac{2(i_3 - i_1) + 4i_3}{i_3 - i_2} = -\frac{2(-1-2) + 4(-1)}{-1-(-3)} = 5\ \Omega$$