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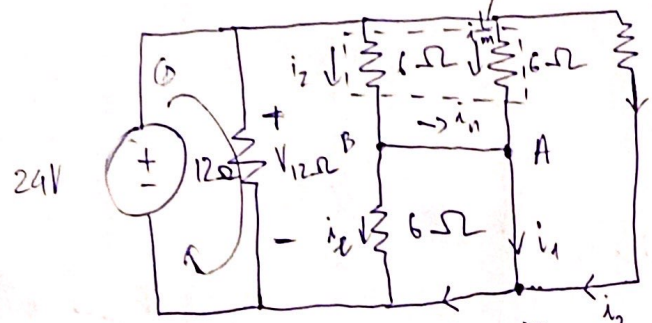
HW1

(1)



$R_{6\Omega} // R_{6\Omega} \Rightarrow \frac{6\times 6}{6+6} = 3\Omega$

$i_{4\Omega} = 6A$

$i_x = 0$

APPLY KVL:

$-24 + i_{4\Omega} 4 = 0$

$\Leftrightarrow i_{4\Omega} = 6A = i_2$

$-24 + i_2 6 + i_x 6 = 0$

$\Rightarrow i_2 = 4A$

$-24 + i_m 6 = 0 \Leftrightarrow i_m = 4A$

APPLY KCL

Node B: $i_2 = i_x + i_n$

$\Leftrightarrow 4 = 0 + i_n$

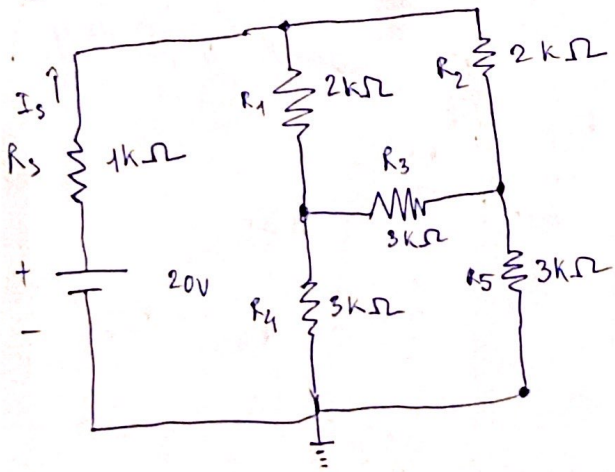
$\Leftrightarrow i_n = 4A$

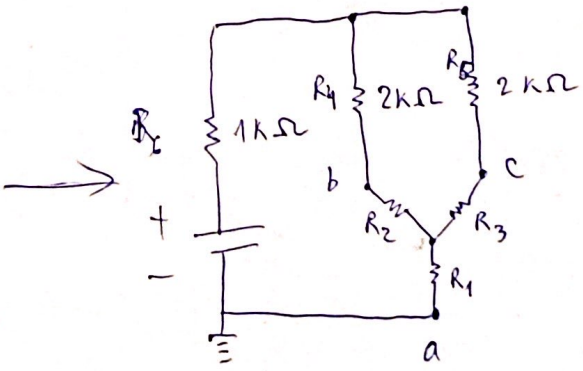
Node A: $i_1 = i_n + i_m$

$= 4 + 4 = 8A$

Node X: $i_x = i_1 + i_2 = 8 + 6 = \boxed{14A}$

(5)





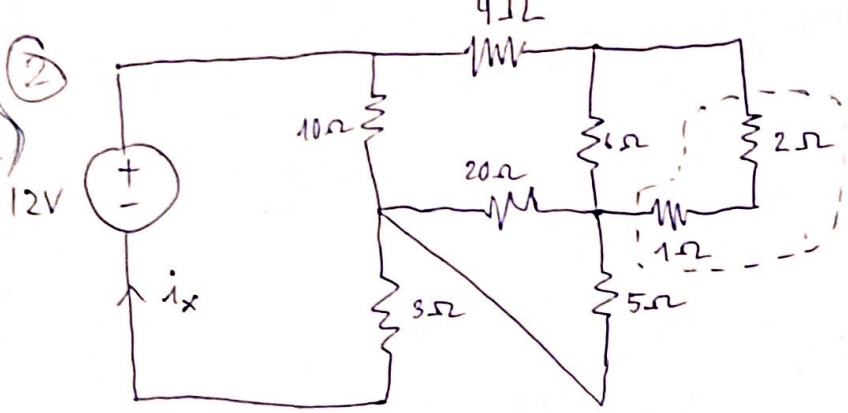
$$R_1 = R_2 = R_3 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{9}{9} = 1k\Omega$$

$$R_{eq} = 1 + [(2+1) // (2+1)] + 1 = 1 + 1{,}5 + 1 = 3.5k\Omega$$

$$I_s = \frac{U}{R_{eq}} = \frac{20}{3.5} = \boxed{5.7mA}$$

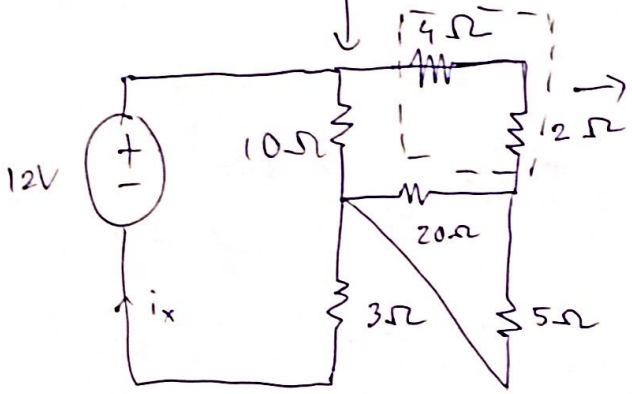
(2)

a)



$\rightarrow R_{1\Omega} + R_{2\Omega} = 3\Omega$

$(R_{1\Omega} + R_{2\Omega}) // R_{6\Omega} = \frac{3\times 6}{3+6} = 2\Omega$



$\rightarrow R_{2\Omega} + R_{4\Omega} = 6\Omega$

$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{5}{3} = 1.67\ \Omega$

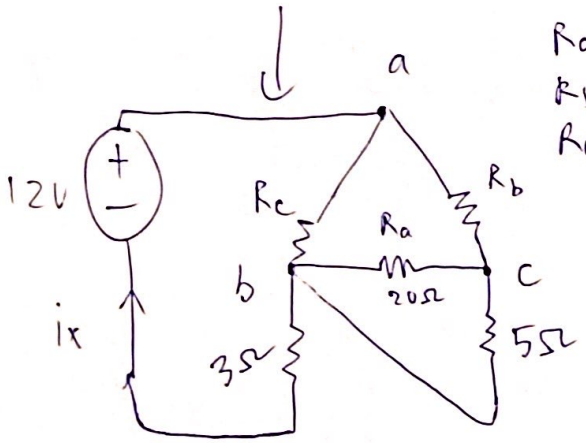
$R_2 = \frac{50}{9} \simeq 5.56\ \Omega$

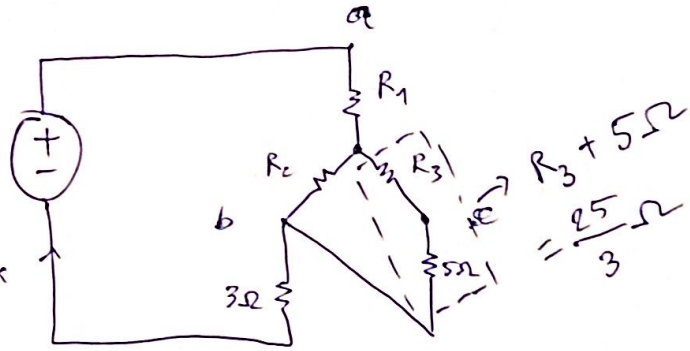
$R_3 = \frac{10}{3} \simeq 3.33\ \Omega$

$R_a = 20\Omega$

$R_b = 6\Omega$

$R_c = 10\Omega$





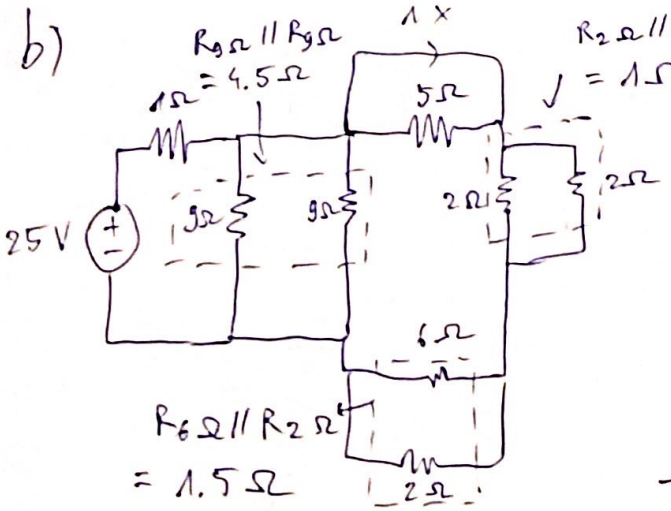
$R_3 + 5\Omega = \frac{25}{3}\Omega$

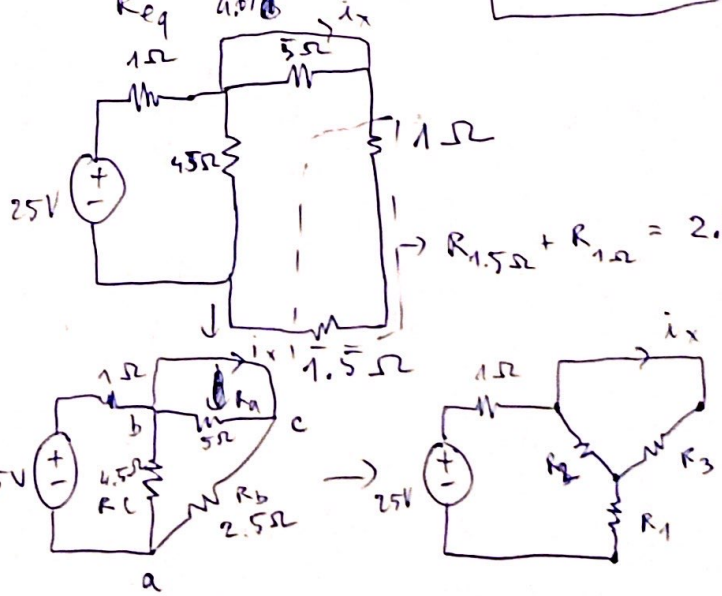
$R_{eq} = 3 + R_1 + \left[\left(R_2 // \frac{25}{3}\right) // 10\right]$

$= 3 + \frac{5}{3} + \frac{\cancel{10}}{\cancel{3}} = \cancel{8} 4.67\Omega$

$\Rightarrow i_x = \frac{U}{R_{eq}} = \frac{12}{4.67} = \cancel{1.5}\ \boxed{2.57\ A}$

b)





$$R_1 = \frac{R_b R_c}{R_a + R_b + R_c} = \frac{\text{illegible}}{5 + 2.5 + 4.5} = \frac{15}{16} \approx 0.9375\ \Omega$$

(2)

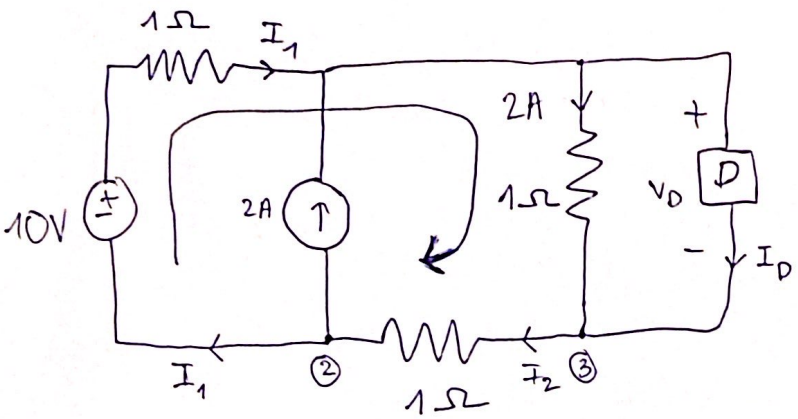
$$R_2 = \frac{R_a R_c}{R_a + R_b + R_c} = \frac{15}{8} \approx 1.875\ \Omega$$

$$R_3 = \frac{R_a R_b}{R_a + R_b + R_c} = \frac{25}{24} \approx 1.042\ \Omega$$

$$R_{eq} = 1 + \frac{15}{16} + [R_2 \,//\, R_3] = 1 + \frac{15}{16} + \frac{75}{112} = \frac{23}{28} \approx 2.61\ \Omega$$

$$I_x = \frac{U}{R_{eq}} = 9.58\ A$$

(3)



node ②: $I_2 = I_1 + 2$

$\Leftrightarrow I_1 - I_2 = -2$ (1)

KVL: $-10 + I_1 + 2 + I_2 = 0$

$\Leftrightarrow I_1 + I_2 = 8$ (2)

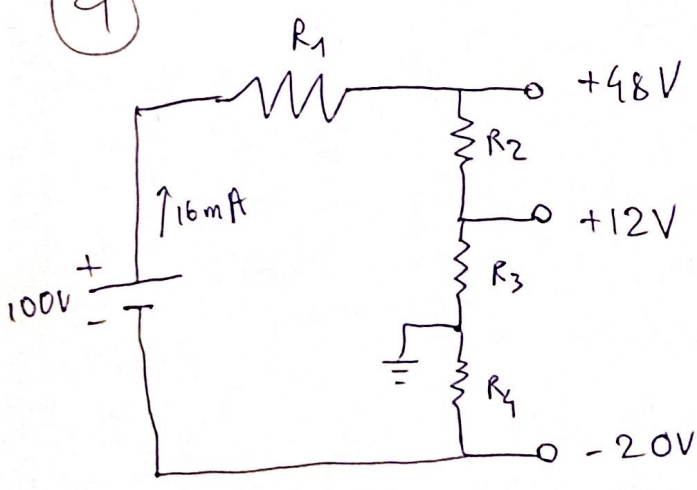
From (1) (2) $\Rightarrow \begin{cases} I_1 = 3\ A \\ I_2 = 5\ A \end{cases}$

node ③ $I_2 = I_D + 2$

$\Leftrightarrow I_D = 3\ A$

$\Rightarrow P_D = I_D V_D = 3 \times 3 = 9\ W$

(4)



$$48 = \frac{R_2 + R_3}{R_2 + R_3 + R_4} \times 100 \Leftrightarrow 48(R_2 + R_3 + R_4) = 100(R_2 + R_3)$$

$$12 = \frac{R_3}{R_2 + R_3 + R_4} \times 100 \Leftrightarrow 12(R_2 + R_3 + R_4) = R_3 \cdot 100$$

$$-20 = \frac{R_4}{R_2 + R_3 + R_4} \times 100 \Leftrightarrow -20(R_2 + R_3 + R_4) = R_4 \cdot 100$$

$$\begin{cases} 52R_2 + 48R_3 + 48R_4 = 0 \\ 12R_2 + 88R_3 + 12R_4 = 0 \\ -20R_2 - 20R_3 - 120R_4 = 0 \end{cases} \Leftrightarrow \begin{cases} R_2 = \\ R_3 = \\ R_4 = \end{cases}$$

$$P_S = I V = 16 \times 10^{-3} \times 100 = 1.6\ W = \frac{V^2}{R_{eq}} = \frac{100^2}{R_{eq}}$$

$\Rightarrow R_{eq} = 6250\ \Omega$

(4)

$R_2 + R_3 + R_4 = 6250 - R_1$

$48(6250 - R_1) = 100 R_2 \Rightarrow R_2 = \frac{48(6250 - R_1)}{100}$

$12(6250 - R_1) = 100 R_3 \Rightarrow R_3 = \frac{12(6250 - R_1)}{100}$

$-20(6250 - R_1) = 100 R_4 \Rightarrow R_4 = \frac{-20(6250 - R_1)}{100}$

$R_{eq} = \frac{U}{I} = \frac{100}{0.016} = 6250\ \Omega$

$48 = 100 \frac{R_2 + R_3}{6250} \Rightarrow R_2 + R_3 = 3000\ \Omega \Rightarrow R_2 = 2250\ \Omega$

$12 = 100 \frac{R_3}{6250} \Rightarrow R_3 = 750\ \Omega$

$-20 = 100 \frac{R_4}{6250} \Rightarrow R_4 = 1250\ \Omega$

$R_1 = 6250 - 1250 - 750 - 2250 = 2000\ \Omega$