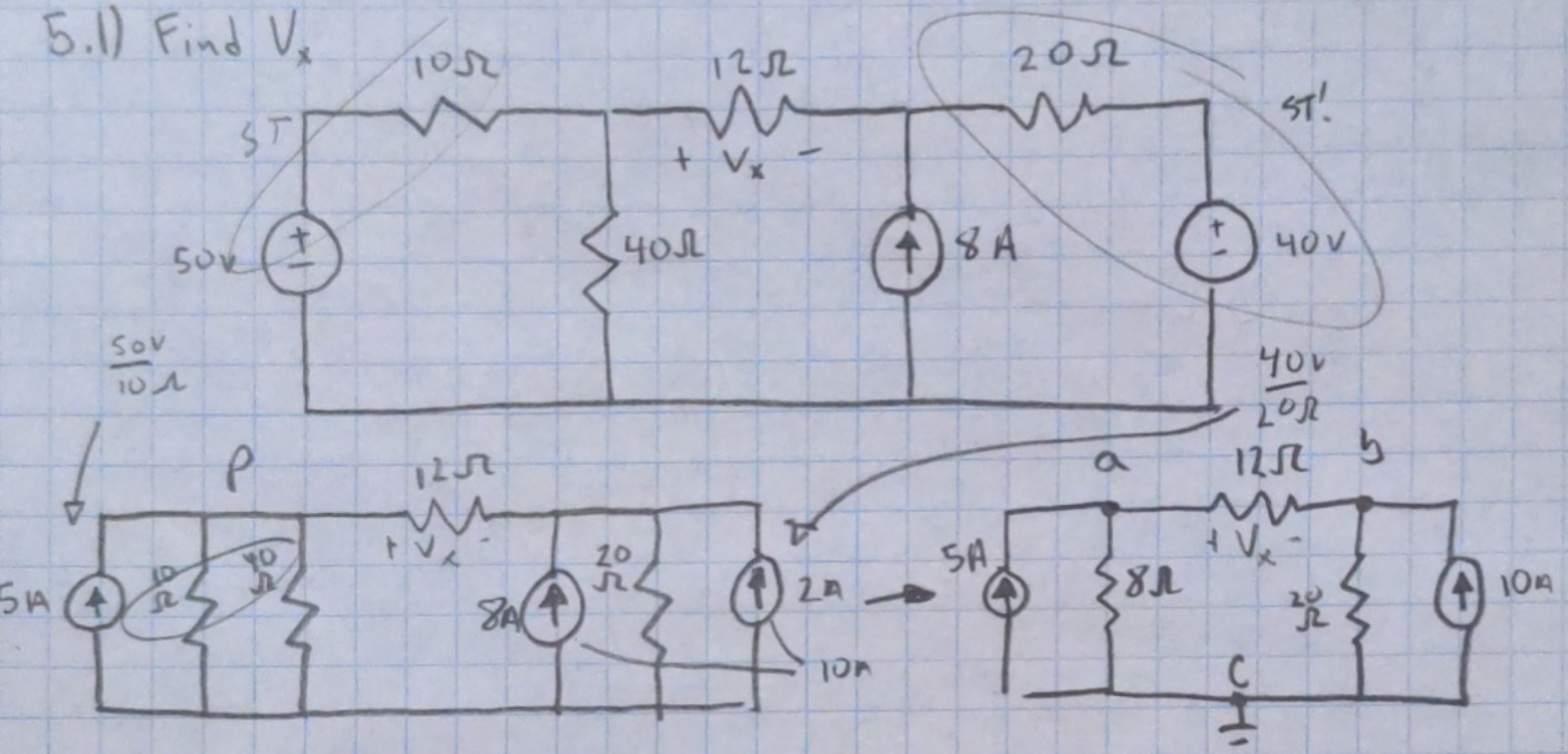
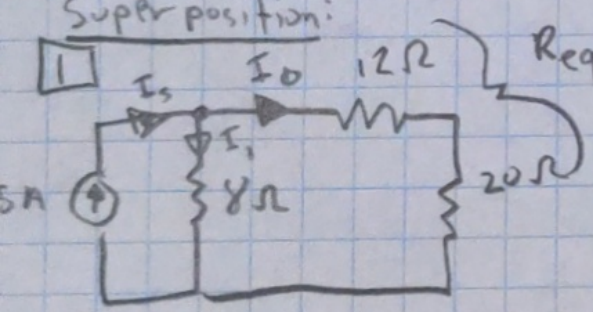
Chris Hunt Homework 5 ENGR 201

5.1) Find V_x



Superposition:

1

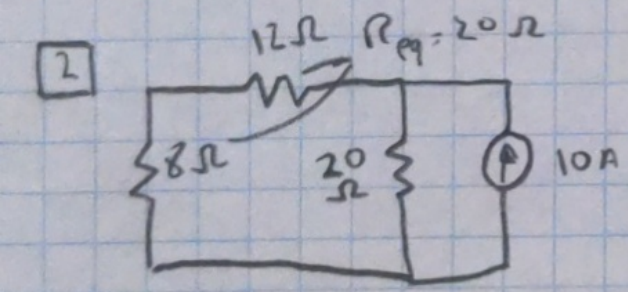


$I_o = 5A\left(\frac{8\Omega}{40\Omega}\right)$

$I_o = 1A$

$V_{o1} = 1A \cdot 12\Omega \rightarrow V_{o1} = 12V$

2



$I_o = 10A\left(\frac{20\Omega}{40\Omega}\right)$

$I_o = 5A$

$V_{o2} = 5A \cdot 12\Omega \rightarrow V_{o2} = 60V$

$V_x = V_{o1} - V_{o2} \rightarrow \boxed{V_x = -48V}$

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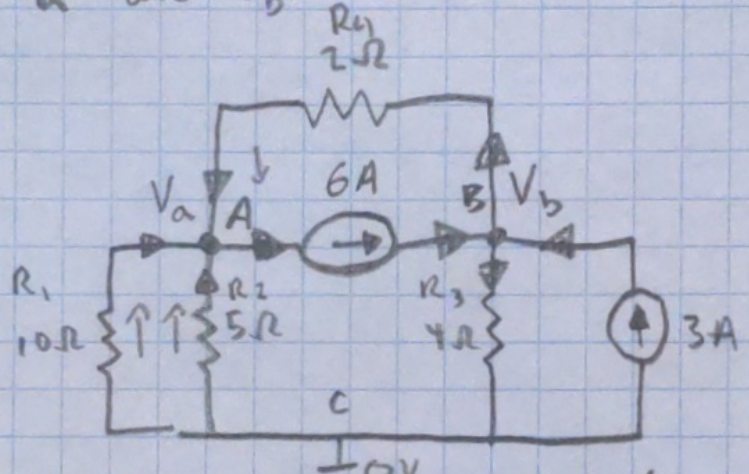
5.2) Find V_a and V_b



@A) $\left(6A = \frac{-V_a}{10\Omega} - \frac{V_a}{5\Omega} + \frac{V_b - V_a}{2\Omega}\right) 10\Omega$

$60V = -V_a - 2V_a + 5V_b - 5V_a$

$60V = -8V_a + 5V_b$

@B) $\left(\underset{9A}{6A + 3A} = \frac{V_b - V_a}{2\Omega} + \frac{V_b}{4\Omega}\right) 4\Omega$

$36V = 2V_b - 2V_a + V_b$

$36V = -2V_a + 3V_b$

$V_a \quad V_b$

$$+\left(-4 \cdot \begin{bmatrix} -8 & 5 \\ -2 & 3 \end{bmatrix} \quad \begin{bmatrix} 60 \\ 36 \end{bmatrix}\right)$$

$$\frac{-7V_b}{-7} = \frac{-84}{-7} \rightarrow V_b = 12V$$

$V_a = 0V$

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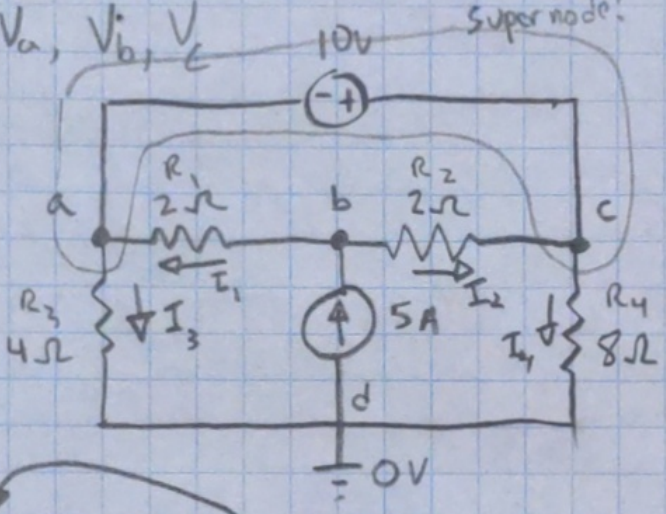
5.3) Find V_a, V_b, V_c



@ supernode voltage diff:

$V_c = V_a + 10v$

$10v = V_c - V_a$

@ supernode: $I_1 + I_2 = I_3 + I_4$

$\left(5A = \frac{V_a}{4\Omega} + \frac{V_c}{8\Omega}\right) 8\Omega$

$40v = 2V_a + V_c$

@ b: $5A = I_1 + I_2$

$\left(5A = \frac{V_b - V_a}{2\Omega} + \frac{V_b - V_c}{2\Omega}\right) 2\Omega$

$10v = V_b - V_a + V_b - V_c$

$10v = -V_a + 2V_b - V_c$

$$\underset{A}{\begin{bmatrix} 2 & 0 & 1 \\ -1 & 2 & -1 \\ -1 & 0 & 1 \end{bmatrix}} \underset{x}{\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix}} = \underset{B}{\begin{bmatrix} 40 \\ 10 \\ 10 \end{bmatrix}}$$

$A^{-1}B = X$

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 10v \\ 20v \\ 20v \end{bmatrix}$$

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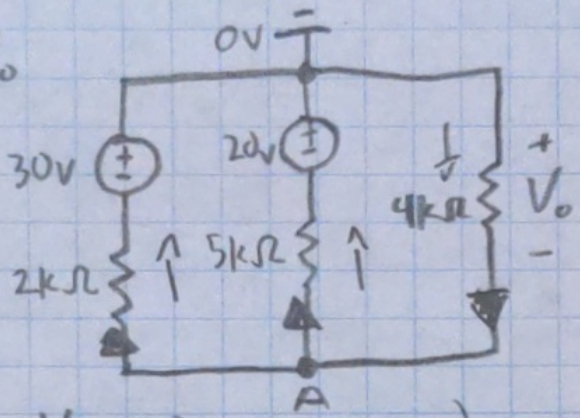
5.4) Find V_o



@A: $\left(\frac{0-V_a}{4k\Omega} = \frac{V_a+20V}{5k\Omega} + \frac{V_a+30V}{2k\Omega}\right) 20k\Omega$

$-5V_a = 4V_a + 80V + 10V_a + 300V$

$-4V_a \qquad -10V_a$

$-19V_a = 380V \rightarrow V_a = -20V$

$V_o = 0 - V_a$

$V_o = 0 - (-20)$

$\boxed{V_o = 20V}$

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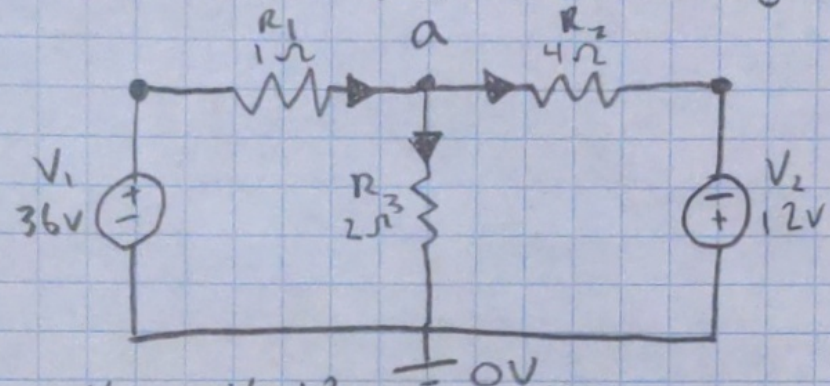
5.5) Find V_a and the power dissipated by each resistor.



@a) $\left(\frac{36v - V_a}{1\Omega} = \frac{V_a + 12v}{4\Omega} + \frac{V_a}{2\Omega}\right) 4\Omega$

$144v - 4V_a = V_a + 12v + 2V_a$

$132v = 7V_a \rightarrow \boxed{V_a = \frac{132}{7} V}$

$P = \frac{V^2}{R}$

$P_1 = \frac{\left(36 - \frac{132}{7}\right)^2}{1}$

$\boxed{P_1 = 293.88\ W}$

$P_2 = \frac{\left(\frac{132}{7} - (-12)\right)^2}{4}$

$\boxed{P_2 = 238\ W}$

$P_3 = \frac{\left(\frac{132}{7} - 0\right)^2}{2}$

$\boxed{P_3 = 177.8\ W}$

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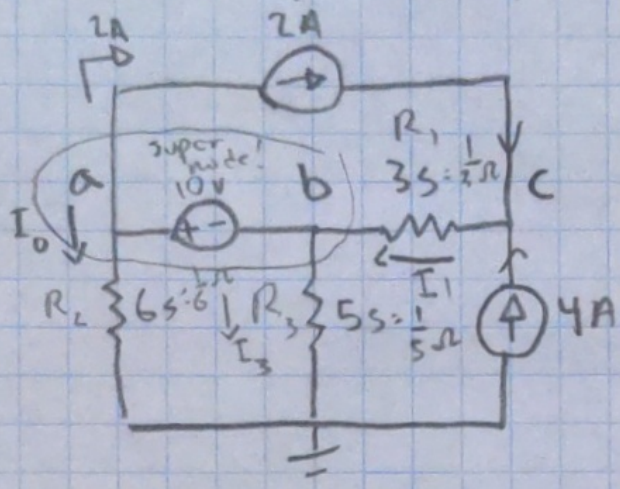
5.6) Find i_o and the power dissipated in each resistor.



supernode:

$V_a = V_b + 10V$

$10 = V_a - V_b$

@ supernode:

$$\frac{(V_c - V_b)}{\frac{1}{3}\Omega} = 2A + \frac{V_a}{\frac{1}{6}\Omega} + \frac{V_b}{\frac{1}{5}\Omega} \quad | \cdot 1\Omega$$

@c $6A = \frac{(V_c - V_b)}{\frac{1}{3}\Omega} \cdot 1\Omega$

$6V = 3V_c - 3V_b$

$3V_c - 3V_b = 2V + 6V_a + 5V_b$

$-6V_c - 5V_b$

$-6V_a - 8V_b + 3V_c = 2V$

$$\underset{A}{\begin{bmatrix} -6 & -8 & 3 \\ 1 & -1 & 0 \\ 6 & -3 & 3 \end{bmatrix}} \underset{X}{\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix}} = \underset{B}{\begin{bmatrix} 2 \\ 10 \\ 6 \end{bmatrix}}$$

$X = A^{-}B$

$$\begin{bmatrix} V_a \\ V_b \\ V_c \end{bmatrix} = \begin{bmatrix} 4.91 \\ -5.09 \\ -3.09 \end{bmatrix}$$

$I_o = \frac{V_a - 0}{R}$

$I_o = \frac{4.91}{\frac{1}{6}}$

$I_o = 29.5A$

$P_1 = \frac{(V_c - V_b)^2}{R_1} = 12W$

$P_2 = \frac{V_a^2}{R_2} = 144.6W$

$P_3 = \frac{V_b^2}{R_3} = 129.5W$