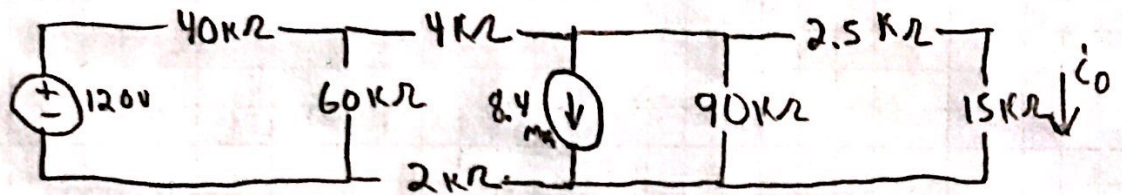
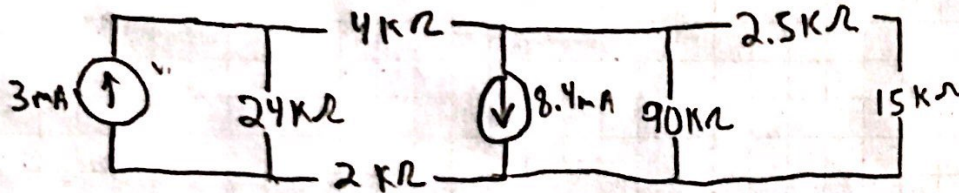


## Problem 1

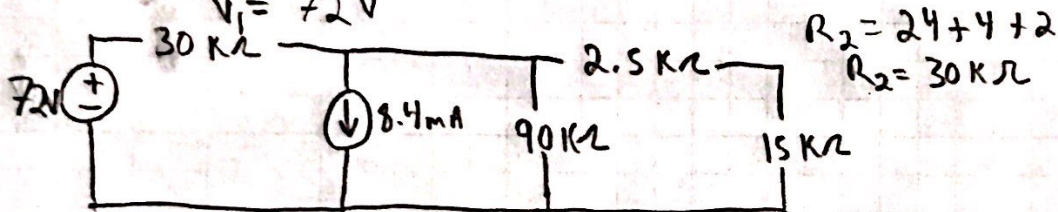


$$i = \frac{120}{90} = 3 \text{ mA}$$

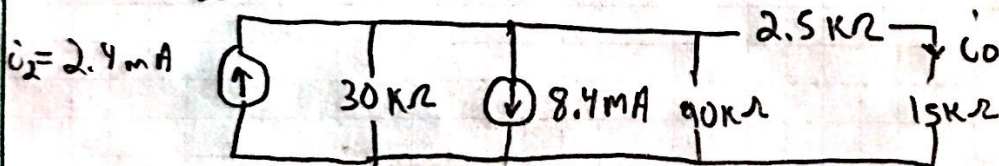


$$V_1 = 3 \text{ mA} (24 \text{ k}\Omega)$$

$$V_1 = 72 \text{ V}$$



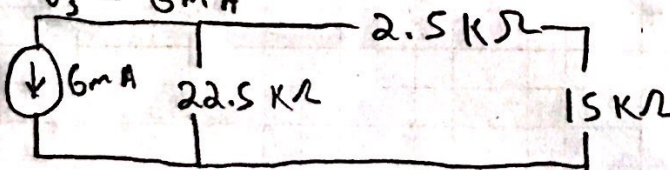
$$i_2 = \frac{72}{30} = 2.4 \text{ mA}$$



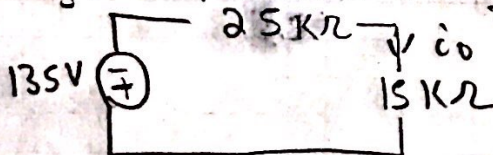
$$R_3 = 22.5 \text{ k}\Omega$$

$$i_3 = 8.4 - 2.4 \text{ mA}$$

$$i_3 = 6 \text{ mA}$$



$$V_3 = 6 \text{ mA} (22.5 \text{ k}\Omega) = 135 \text{ V}$$

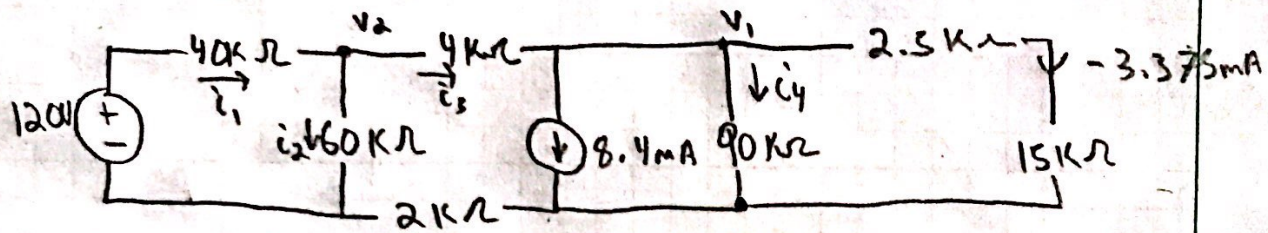


$$i = \frac{V}{R}$$

$$i_0 = -\frac{135}{40}$$

$$i_0 = -3.375 \text{ mA}$$





$$V_1 = -3.375 (2.5 + 15)$$

$$|V_1 = -59.0625 \text{ V}|$$

$$i_4 = \frac{V}{R} = \frac{-59.0625}{90}$$

$$|i_4 = -0.6563 \text{ mA}|$$

$$i_3 = 8.4 + i_4 - 3.375$$

$$i_3 = 8.4 - 0.6563 - 3.375$$

$$|i_3 = 4.3687 \text{ mA}|$$

$$V_2 = 4.3687(6) + (-59.0625 \text{ V})$$

$$|V_2 = -32.8503 \text{ V}|$$

$$i_2 = \frac{-32.8503}{60 \text{ k}\Omega}$$

$$|i_2 = -0.5475 \text{ mA}|$$

$$i_1 = i_2 + i_3$$

$$i_1 = -0.5475 + 4.3687$$

$$|i_1 = 3.8212 \text{ mA}|$$

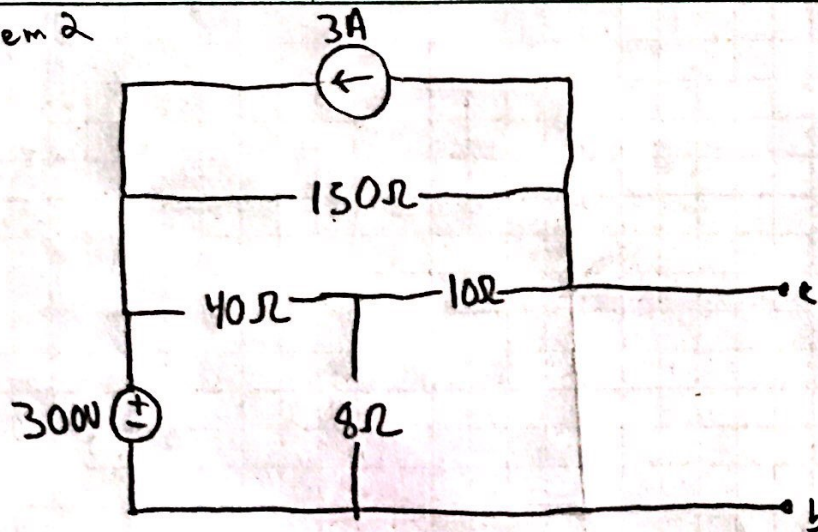
$$P = iV$$

$$P_{120\text{V}} = 3.8212 \text{ mA} (120 \text{ V})$$

$$|P_{120\text{V}} = 0.4585 \text{ W}|$$

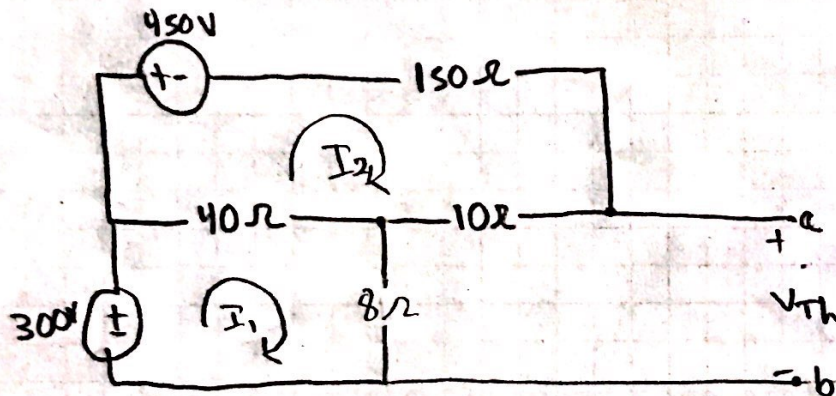


Problem 2



$$V = 3(150)$$

$$V = 450V$$



Mesh current  $I_1$

$$-300 + 40(I_1 - I_2) + 8I_1 = 0$$

$$48I_1 - 40I_2 = 300$$

Mesh current  $I_2$

$$450 + 150I_2 + 10I_2 + 40(I_2 - I_1) = 0$$

$$-40I_1 + 200I_2 = -450$$

$$\begin{bmatrix} 48 & -40 \\ -40 & 200 \end{bmatrix} \begin{bmatrix} I_1 \\ I_2 \end{bmatrix} = \begin{bmatrix} 300 \\ -450 \end{bmatrix}$$

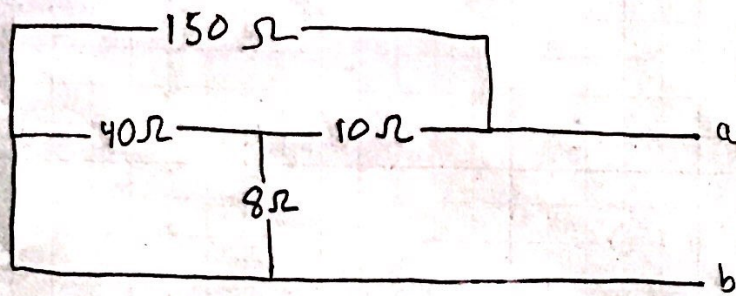
$$I_1 = 5.25A$$

$$I_2 = -1.2A$$

$$V_{Th} = 10I_2 + 8I_1$$

$$V_{Th} = 30V$$



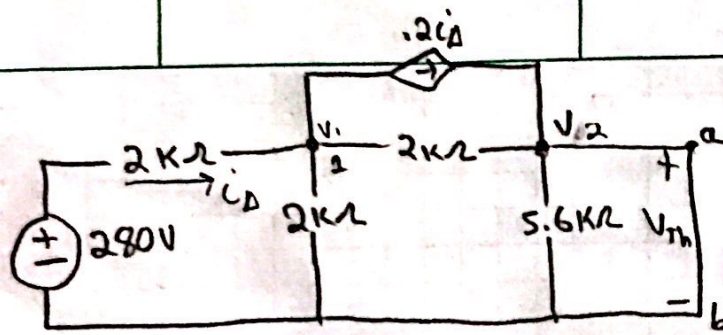


$$\begin{aligned}
 R_{Th} &= \left[ \frac{(40 \parallel 8) + 10}{1} \parallel \frac{150}{1} \right]^{-1} \\
 &= \frac{140(8)}{48} + 10 = 16.67 \\
 &= \frac{16.67(150)}{16.67 + 150}
 \end{aligned}$$

$$R_{Th} = 15 \Omega$$



### Problem 3



$$i_{\Delta} = \frac{280 - v_1}{2000}$$

$$v_2 = 0V$$

KVL 1

$$\frac{v_1 - 280}{2000} + \frac{v_1}{2000} + \frac{v_1 - v_2}{2000} = -0.2i_{\Delta}$$

$$3v_1 - 280 - v_2 = -400i_{\Delta}$$

sub.  $3v_1 - 280 - v_2 = -400 \left( \frac{280 - v_1}{2000} \right)$

$$3v_1 - 280 = -56 + 0.2v_1$$

$$v_1 = 80V$$

$$i_{\Delta} = \frac{280 - 80}{2000}$$

$$i_{\Delta} = 0.1A$$

KVL 2

$$i_{sc} = (0.2)(0.1) + \frac{80}{2000}$$

$$i_{sc} = 0.06A$$

KCL 1

$$3v_1 - 280 - v_2 = -400 \left( \frac{280 - v_1}{2000} \right)$$

$$3v_1 - v_2 - 280 = -56 + 0.2v_1$$

$$2.8v_1 = 224 + v_2$$

$$v_1 = \frac{224 + v_2}{2.8}$$

KCL 2

$$\frac{v_2}{5600} + \frac{v_2 - v_1}{2000} = 0.2 \left( \frac{280 - v_1}{2000} \right)$$

$$-14v_1 + 19v_2 = 5600i_{\Delta}$$



$$-14V_1 + 19V_2 = 5600 \left( \frac{280 - V_1}{2000} \right)$$

$$-14V_1 + 19V_2 = 784 - 2.8V_1$$

$$-11.2V_1 + 19V_2 = 784$$

$$\text{Sub } \frac{224 + V_2}{2.8} \Rightarrow -11.2 \left( \frac{224 + V_2}{2.8} \right) + 19V_2 = 784$$

$$-896 - 4V_2 + 19V_2 = 784$$

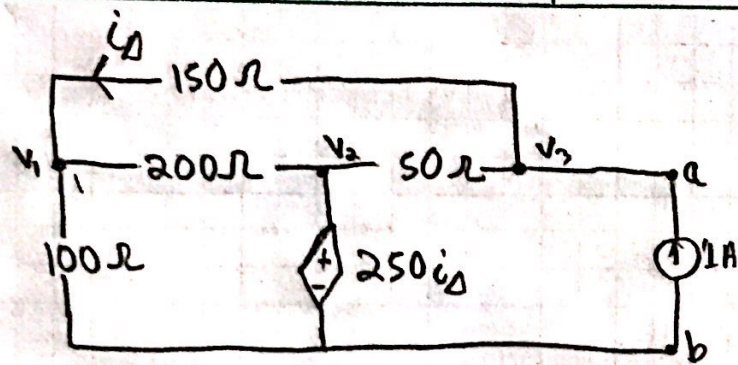
$$V_{Th} = V_2 = 112V$$

$$R_N = \frac{V_{Th}}{I_{sc}} = \frac{112V}{0.06A}$$

$$R_N = 1866.7 \Omega$$



# Problem 4



$$i_D = \frac{v_3 - v_1}{150}, \quad v_2 = 250 i_D$$

$$v_2 = 250 \left( \frac{v_3 - v_1}{150} \right) \Rightarrow -\frac{5}{3}v_1 - v_2 + \frac{5}{3}v_3 = 0$$

KCL Node 1

$$\frac{v_1}{100} + \frac{v_1 - v_3}{150} + \frac{v_1 - v_2}{150} = 0$$

$$\frac{6v_1 + 3v_1 - 3v_2 + 4v_1 - 4v_3}{600} = 0$$

$$13v_1 - 3v_2 - 4v_3 = 0$$

KCL Node 3

$$\frac{v_3 - v_2}{50} + \frac{v_3 - v_1}{150} = 1$$

$$3v_3 - 3v_2 + v_3 - v_1 = 150$$

$$-v_1 - 3v_2 + 4v_3 = 150$$

$$\begin{bmatrix} -5/3 & -1 & 5/3 \\ 13 & -3 & -4 \\ -1 & -3 & 4 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 150 \end{bmatrix}$$

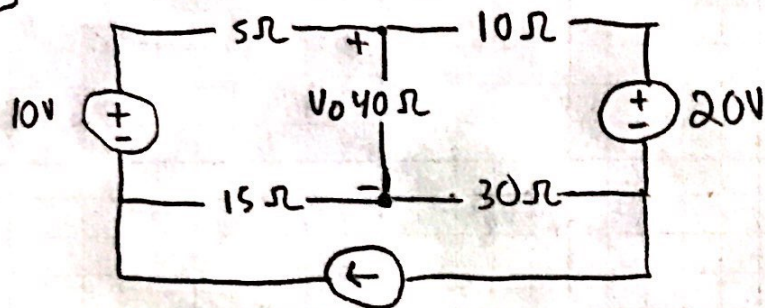
$$v_3 = 150V$$

$$R_{Th} = \frac{150V}{1A}$$

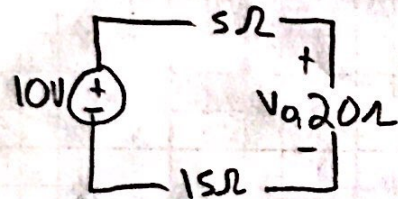
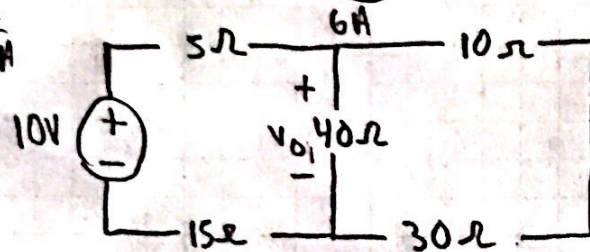
$$R_{Th} = 150 \Omega$$



# Problem 5



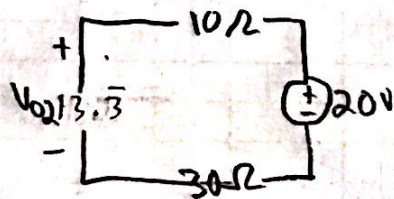
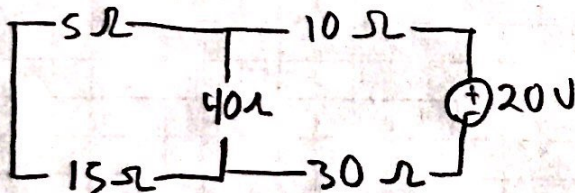
Deactivate  
20V & 6A



$$V_0 = \frac{20}{20 + 15 + 5} (10)$$

$$V_{01} = 5V$$

Deactivate  
10V & 6A

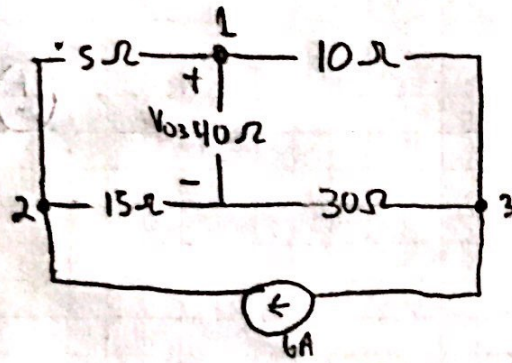


$$V_{02} = 20 \left( \frac{13.3}{13.3 + 10 + 30} \right)$$

$$V_{02} = 5V$$



Deactivate  
10V & 20V



KCL 1

$$\frac{V_{03}}{40} + \frac{V_{03} - V_2}{10} + \frac{V_{03} - V_2}{5} = 0$$

$$\frac{V_{03} + 4V_{03} - 4V_2 + 8V_{03} - 8V_2}{40} = 0$$

$$13V_{03} - 8V_2 - 4V_2 = 0$$

KCL 2

$$\frac{V_2 - V_{03}}{5} + \frac{V_2}{15} + 6 = 0$$

$$3V_2 - 3V_{03} + V_2 - 90 = 0$$

$$-3V_{03} + 4V_2 = 90$$

KCL 3

$$\frac{V_3}{30} + \frac{V_3 - V_{03}}{10} + 6 = 0$$

$$3V_3 - 3V_{03} + V_3 + 180 = 0$$

$$-3V_{03} + 4V_3 = -180$$

$$\begin{bmatrix} 13 & -8 & -4 \\ -3 & 4 & 0 \\ -3 & 0 & 4 \end{bmatrix} \begin{bmatrix} V_{03} \\ V_2 \\ V_3 \end{bmatrix} = \begin{bmatrix} 0 \\ 90 \\ -180 \end{bmatrix}$$

$$\underline{V_{03} = 0V}$$

$$V_0 = V_{01} + V_{02} + V_{03}$$

$$V_0 = 5V + 5V + 0$$

$$\boxed{V_0 = 10V}$$