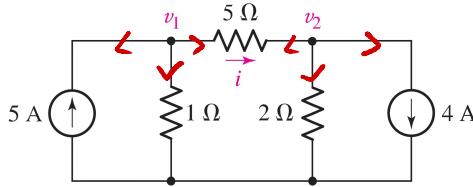


Node voltage method

Q 1:



$$\vartheta = \omega t$$
$$\hat{M} = \frac{\vartheta}{t}$$

$$① \frac{v_1}{1\Omega} + \frac{v_1 - v_2}{5\Omega} - 5 = 0$$

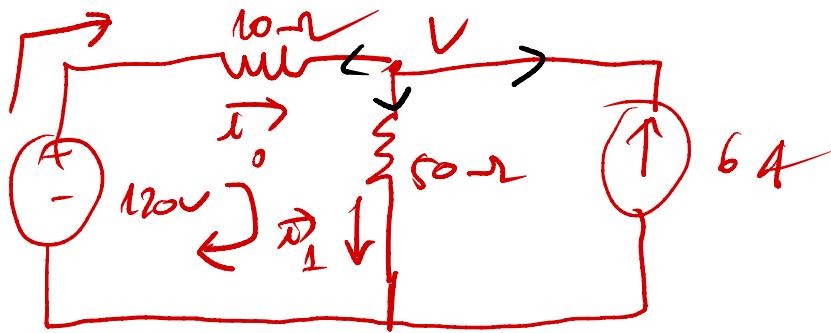
$$② v_1 \left(1 + \frac{1}{5} \right) + v_2 \left(-\frac{1}{5} \right) = 4$$

$$③ \frac{v_2 - v_1}{5\Omega} + \frac{v_2}{2\Omega} + 4 = 0$$

$$④ v_1 \left(-\frac{1}{5} \right) + v_2 \left(\frac{1}{5} + \frac{1}{2} \right) = -4$$

$$(1)(2) \Rightarrow \begin{cases} v_1 = 3.375 \text{ V} \\ v_2 = -4.75 \text{ V} \end{cases}$$

$$i = \frac{v_1 - v_2}{5} = \frac{3.375 + 4.75}{5} = 1.625 \text{ A}$$

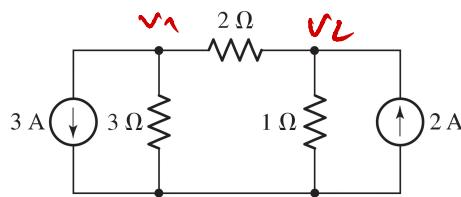


$$\frac{V - 120}{10 \Omega} + \frac{V}{50 \Omega} - 6 = 0$$

$$\Rightarrow V = 150 \text{ V}$$

$$i = \frac{V}{R} = \frac{150}{50} = 3 \text{ A}$$

Q2 :

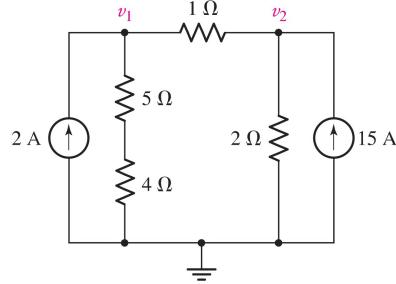


$$3 + \frac{V_1}{3\Omega} + \frac{V_1 - V_2}{2\Omega} = 0$$
$$\Rightarrow V_1 \left(\frac{1}{3} + \frac{1}{2} \right) + V_2 \left(-\frac{1}{2} \right) = -3 \quad (1)$$

$$\frac{V_2}{1\Omega} + \frac{V_2 - V_1}{2\Omega} - 2 = 0$$
$$\Rightarrow V_1 \left(-\frac{1}{2} \right) + V_2 \left(1 + \frac{1}{2} \right) = 2 \quad (2)$$

$$(1)(2) \Rightarrow \begin{cases} V_1 = -3.5 \text{ V} \\ V_2 = 0.167 \text{ V} \end{cases}$$

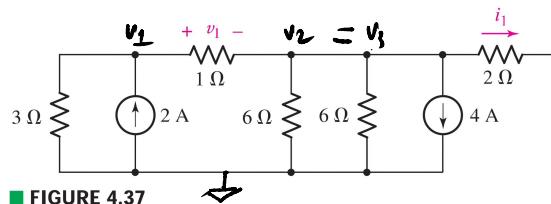
Q 3:



Q 4:

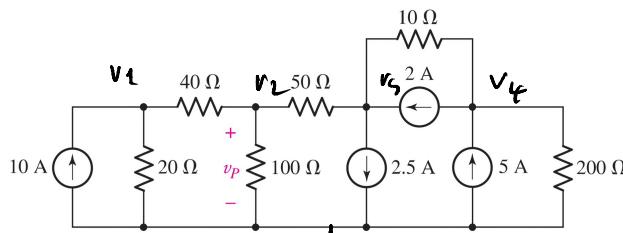
$$v_1 = -1.71$$

$$v_2 = -4.29$$



■ FIGURE 4.37

Q5:



$$\text{Node 1: } \frac{v_1}{20} + \frac{v_1 - v_2}{40} = 10 \quad \left. \begin{array}{l} \\ \end{array} \right\} v_1 = 32.3$$

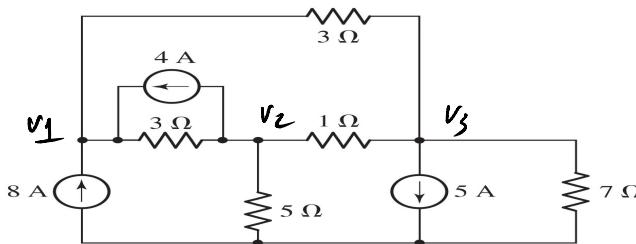
$$\text{Node 2: } \frac{v_2}{100} + \frac{v_2 - v_1}{20} + \frac{v_2 - v_3}{50} = 0 \quad \left. \begin{array}{l} \\ \end{array} \right\} v_2 = -303.07$$

$$\text{Node 3: } \frac{v_3 - v_4}{10} = -0.5 \quad \left. \begin{array}{l} \\ \end{array} \right\} v_3 = 495$$

$$\text{Node 4: } \frac{v_4}{200} + \frac{v_4 - v_3}{10} = 3 \quad \left. \begin{array}{l} \\ \end{array} \right\} v_4 = 500$$

$$\text{Node 2: } v_1 \left(-\frac{1}{40} \right) + v_2 \left(\frac{1}{100} + \frac{1}{50} \right) + v_3 \left(-\frac{1}{10} \right)$$

Q6



$$\text{Node 1: } \frac{v_2 - v_1}{3} + \frac{v_1 - v_3}{3} - 8 - 4 = 0$$

$$\text{Node 2: } \frac{v_2 - v_1}{3} + \frac{v_2}{5} + \frac{v_2 - v_3}{1} + 4 = 0$$

$$\text{Node 3: } \frac{v_3 - v_1}{3} + \frac{v_3 - v_2}{1} + \frac{v_3}{7} + 5 = 0$$

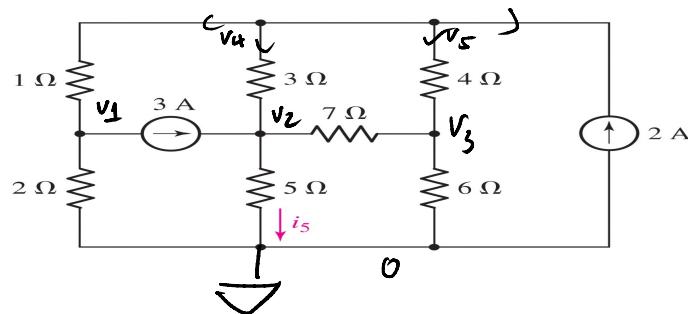
$$v_1\left(\frac{1}{3} + \frac{1}{3}\right) + v_2\left(-\frac{1}{3}\right) + v_3\left(-\frac{1}{3}\right) = 12$$

$$v_1\left(-\frac{1}{3}\right) + v_2\left(\frac{1}{3} + \frac{1}{5} + 1\right) + v_3\left(-1\right) = -4$$

$$v_1\left(-\frac{1}{3}\right) + v_2\left(-1\right) + v_3\left(\frac{1}{3} + \frac{1}{7}\right) = 5$$

$$\begin{cases} v_1 = 26.733 \\ v_2 = 8.8333V \\ v_3 = 8.6333V \end{cases}$$

Q7:



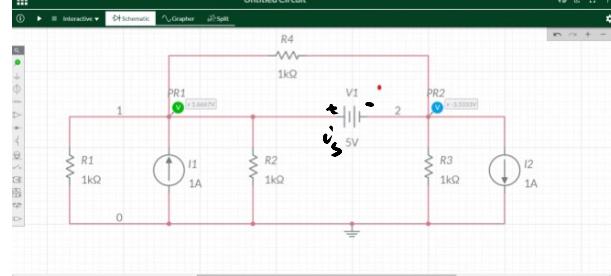
$$\text{Node 1: } 3 + \frac{v_1}{2} + \frac{v_1 - v_4}{1} = 0 \quad (=)$$

$$\text{Node 2: } \frac{v_2}{5} - 3 + \frac{v_2 - v_4}{3} + \frac{v_2 - v_3}{7} = 0$$

$$\text{Node 3: } \frac{v_3}{6} + \frac{v_3 - v_2}{7} + \frac{v_3 - v_5}{4} = 0$$

$$\text{Node 4: } \frac{v_4 - v_1}{1} + \frac{v_4 - v_2}{3} = 0$$

$$\text{Node 5: } \frac{v_5 - v_3}{4} - 2 = 0$$



$$S_{\text{opf node}}: \frac{v_1}{1000} = \cancel{1} + \frac{v_1 - v_2}{1000} + \frac{v_1}{1000} + \frac{v_2 - v_1}{1000} + \frac{v_2}{1000} \quad \cancel{+ 1}$$

$$\Rightarrow \begin{cases} v_1 \left(\frac{1}{500} \right) + v_2 \left(\frac{1}{1000} \right) = 0 \\ v_1 - v_2 = 5 \end{cases} \Rightarrow \begin{cases} v_1 = \frac{5}{3} \\ v_2 = -\frac{10}{3} \end{cases}$$

$$\text{Node 1: } \frac{v_1 - 256}{150} + \frac{v_1 - v_3}{300} + \frac{v_1 - 50i_A}{100} + \frac{v_1}{200}$$

$$\text{Node 3: } \frac{v_3 - 128}{500} + \frac{v_3 - 50i_A}{250} + \frac{v_3}{400} + \frac{v_3 - v_1}{300} = 0$$

$$i_A = \frac{v_3 - v_1}{500} \rightarrow 50i_A = \frac{v_3 - v_1}{6}$$

$$(1) \quad \frac{7v_1 - v_3}{600}$$

$$(2) \quad \frac{v_1 + 5v_3}{1500}$$

3

$$\text{Supermesh: } 4i_a + 6i_a + 2.5i_b + 7.5i_b + 8i_c + 2i_c - 193 + 0.8v_\theta = 0$$

$$i_b - i_a = 0.4v_\Delta \quad v_a = 2i_c \\ i_c - v_b = 0.5 \quad v_\theta = -7.5i_b$$

Node 1:

$$\frac{v_A - 15}{2} + \frac{v_A - v_B}{6} + \frac{v_A}{10} = 0$$

Node 2:

$$\frac{v_B - v_A}{6} + \frac{v_B}{10} + \frac{v_B - 3v_a}{2} = 0$$

$$v_a = \frac{v_A - v_B}{6} \Rightarrow 3v_a = \frac{v_A - v_B}{2}$$

$$(1) \Rightarrow \frac{v_B - v_A}{6} + \frac{v_B}{10} + \frac{3v_B - v_A}{4} = 0$$

$$\Rightarrow v_A = \frac{1525}{142}$$

$$v_B = \frac{625}{142} \quad v_a = \frac{v_A - v_B}{6} = \frac{75}{71} \approx 1.06 A$$

$$P_{6\Omega} = v_a^2 \times 6 = 6.7$$

$$P_{10\Omega} \approx 1.94$$

$$\frac{2-1}{25k} + \frac{2-v_0}{100k} = 0$$

$$\Rightarrow v_0 = 6$$

$$\frac{v_b - 1.5}{25k} + \frac{v_b - 6}{100k}$$

$$(v_b - 1.5) 100k + (v_b - 6) 25k = 0$$

$$-6 < 125v_b - 1650 < 10$$

$$\Leftrightarrow 1140 \leq 125v_b \leq 1660$$

$$\Leftrightarrow 15.12 \leq v_b \leq 13.28$$

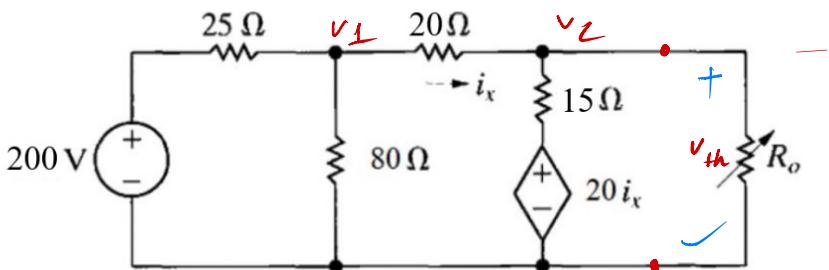


Fig. 1

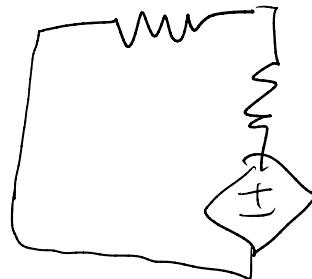
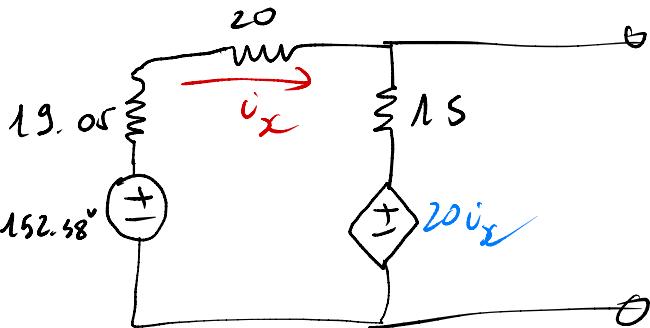
$$\frac{v_1 - 200}{25} + \frac{v_1 - v_2}{20} + \frac{v_1}{80} = 0$$

$$i_x = \frac{v_1 - v_2}{20} \rightarrow 20i_x = v_1 - v_2$$

$$\frac{v_2 - v_1}{20} + \frac{v_2 - 20i_x}{15} = 0$$

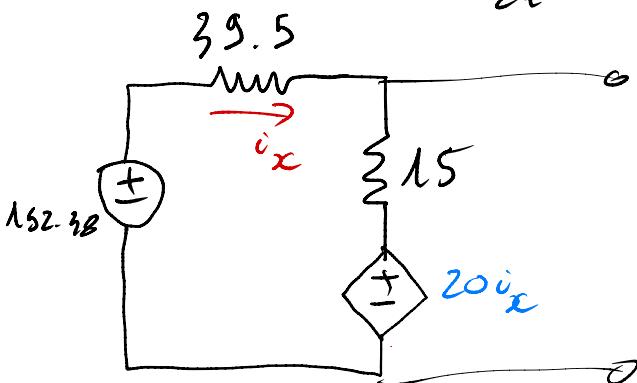
$$\Leftrightarrow \frac{v_2 - v_1}{20} + \frac{-v_1 + 2v_2}{15} = 0$$

$$\Rightarrow \begin{cases} v_1 = 113.18 \\ v_2 = 72.05 \end{cases} = v_{th}$$



$$V = 200 \times \frac{80}{80+20} = \frac{3200}{21} \approx 152.38 \text{ V}$$

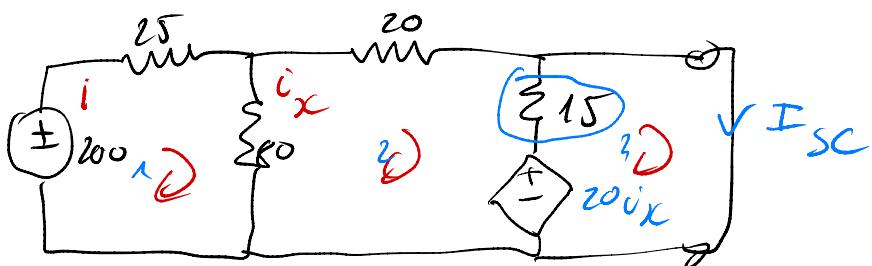
$$R_{eq} = 25 // 80 = \frac{400}{21} \approx 19.05 \text{ V}$$



$$i_x = \frac{152.38 - 20i_x}{54.5}$$

$$\dots \Rightarrow i_x = \frac{640}{311} \approx 2.06 \text{ A}$$

$$V_{th} = 35i_x \approx 72.03 \text{ V}$$



$$V = 72.05$$

Loop 1:

$$\begin{aligned} i(25 + 80) - 80i_x &= 200 \\ \Rightarrow 105i - 80i_x &= 200 \end{aligned} \quad (1)$$

Loop 2:

$$-80i + 135i_x - 15I_{sc} = 0 \quad (2)$$

Loop 3:

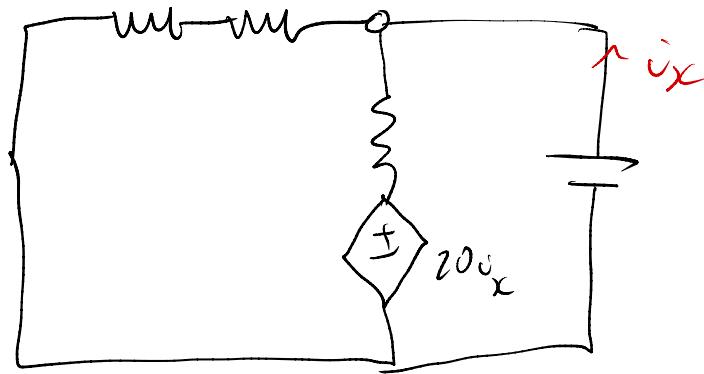
$$\begin{aligned} -20i_x + 15I_{sc} - 15i_x &= 0 \\ \Leftrightarrow -45i_x + 15I_{sc} &= 0 \end{aligned} \quad (3)$$

$$\left\{ \begin{array}{l} i = \\ i_x = \end{array} \right.$$

$$I_{sc} =$$

$$\rightarrow R_{th} = \frac{V_{th}}{I_{sc}} =$$

$$P = \left(\frac{V}{R_{th} + R_o} \right)^2 \times R_o = 100$$



$$\frac{v_T}{20 + (25\pi j 80)} + \frac{v_T - 20(-\frac{v_T}{20})}{15}$$

$$I_T = \frac{v_T}{15} + \frac{v_T}{15}$$

$$I_T = 6.29$$

Ex. 83

$$\frac{v_1 - 200}{25} + \frac{v_1 - v_2}{10} + \frac{v_1}{100} = 0$$

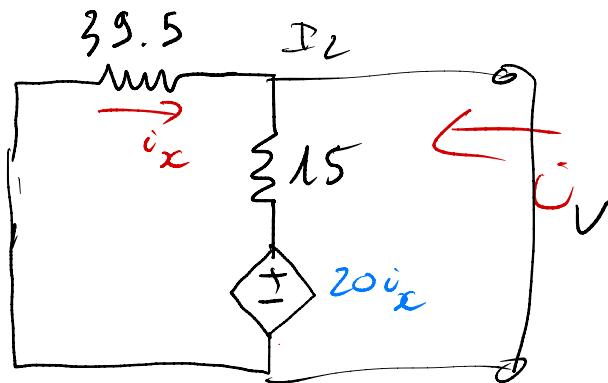
$$i_x = \frac{v_1 - v_2}{10} = \frac{30v_2 - 50v_1}{10} = 3v_2 - 5v_1$$

$$\Rightarrow \frac{v_2 - 30i_x}{10} + \frac{v_2 - v_1}{10} \\ = \frac{-5v_1 + 4v_2}{20} + \frac{v_2 - v_1}{10} = 0$$

$$\Rightarrow \begin{cases} v_1\left(\frac{1}{25} + \frac{1}{100} - \frac{1}{10}\right) + v_2\left(-\frac{1}{10}\right) = \frac{200}{25} \\ v_1\left(-\frac{5}{20} - \frac{1}{10}\right) + v_2\left(\frac{4}{20} + \frac{1}{10}\right) = 0 \end{cases}$$

$$\Rightarrow \begin{cases} v_1 = 120^V \\ v_2 = 100^V \end{cases}$$





$$39.5I_2 = -1V$$

$$\rightarrow I_2 = \frac{-1}{39.5} = -1V$$

$$15(I_x - I_2) + 39.5I_x = 0$$

$$(=) 54.5I_x - 15I = I$$

Consider the circuit in Fig. 3, find the voltage v_o in the circuit while $v_s = 1V$, $R_s = 6k\text{ Ohm}$, $R_f = 30k\text{ Ohm}$, $V_{cc} = 15V$ (unit is required - Round your answer to 2 decimal places).

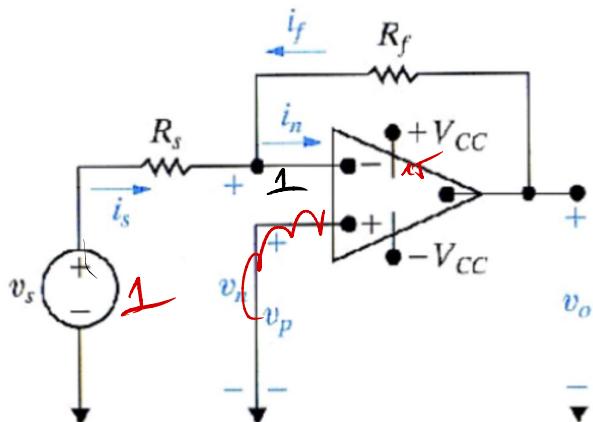


Fig. 3

$$\frac{v_1 - v_s}{R_s} + \frac{v_1 - v_o}{R_f} = 0$$

$$\Rightarrow J = 1$$

$$v_o = -\frac{R_2}{R_1} v_a - \frac{R_2}{R_3} v_b - \frac{R_2}{R_4} v_c$$
$$= \frac{-79}{22} \times 3 - \frac{79}{21} \times 4 - \frac{79}{24} \times 2$$

Consider the circuit in Fig. 5, find the voltage v_o in the circuit while $v_g = 3V$, $R_s = 6k\text{ Ohm}$, $R_f = 6k\text{ Ohm}$, $V_{CC} = 15V$ (unit is required - Round your answer to 2 decimal places).

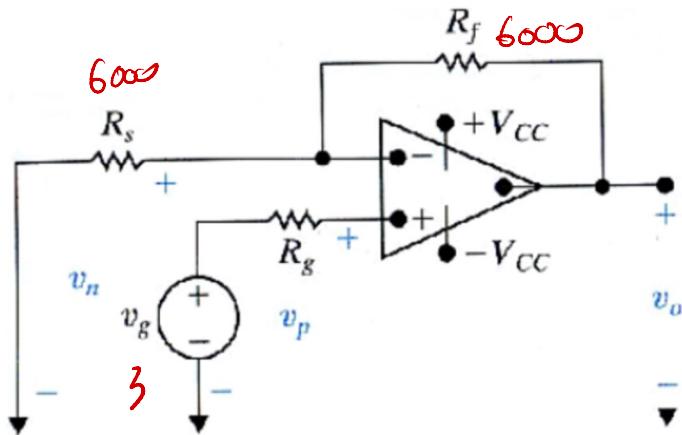
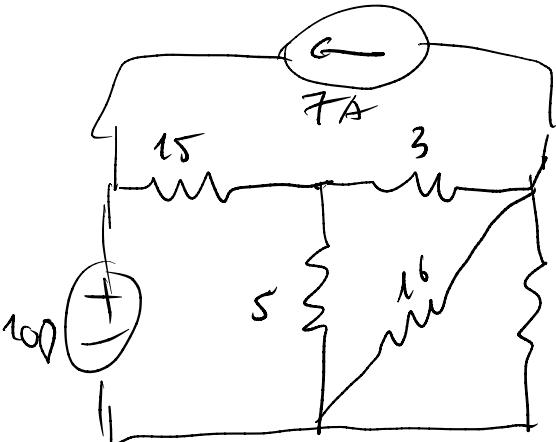


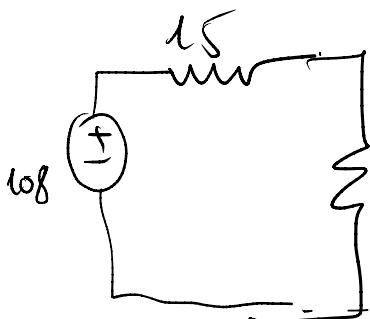
Fig. 5

$$\frac{R_f}{R_s} \cdot v_g =$$

$$\underline{R_g}$$



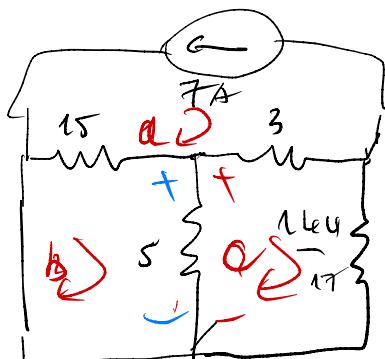
$$R_{eq} = \left((16 \parallel 18) + 3 \right) \parallel 5 = \frac{195}{56}$$



$$V = \frac{100}{\frac{195}{56}} = \frac{468}{23} \text{ Ans} + 15 \approx 20.35$$

$$V = V_1 + V_2 = \frac{132}{32} \approx 5.74 \text{ V}$$

$$i_a = -7A$$



loop b:

$$15(i_b - i_a) + 5(i_b - i_c) = 0$$

$$\Leftrightarrow 15(i_b + 7) + 5(i_b - i_c) = 0$$

loop c:

$$3(i_c - i_a) + 5(i_c - i_b) + \frac{144}{17} i_c = 0$$

$$\Leftrightarrow 3(i_c + 7) + 5(i_c - i_b) + \frac{144}{17} i_c$$

$$\Rightarrow \begin{cases} i_b = -6.93 \\ i_c = -3.57 \end{cases}$$

$$V = 5(i_b - i_c) = -336 \approx -14.61 \text{ V}$$

$$V = 72.05$$

$$R_{th} = 8.58$$

$$P_{max} = \frac{V_{th}^2}{4R}$$

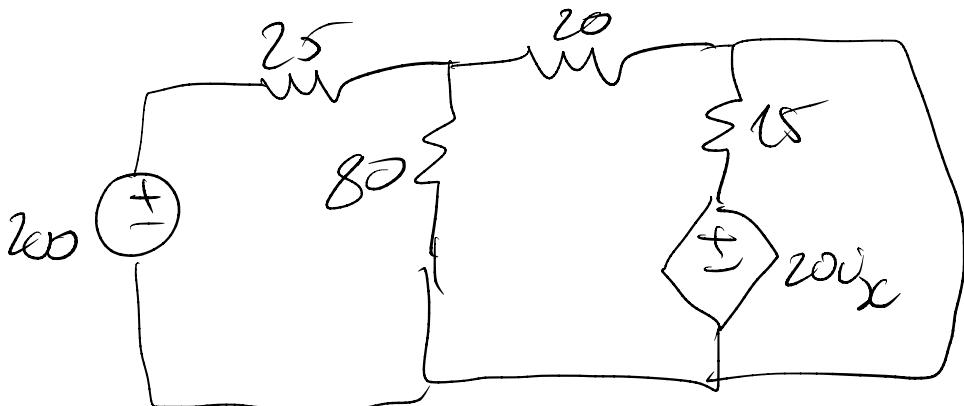
8.2k	1.2
4.7k	2.3
3.3k	2.7
5.6k	5.6
2.7k	4.7
1.2k	
1.5k	
820	
2.2k	
1.15k	
139k	

1.8k

$$\frac{1}{R_{eq}} = i = \frac{V}{R}$$

$$I_1 = \frac{16}{8200} = \frac{2}{1025} \approx 1.95 \text{ mA}$$

$$I_2 = \frac{16}{15k} = \frac{2}{1875} \approx 1.067 \text{ mA}$$



Loop 1 :

$$105i - 80i_x = 200$$

Loop 2 :

$$-80i + 135i_x - 15I_{SC} = 0$$

Loop 3 : $-20i_x + 15I_{SC} - 15i_x = 0$

$$= -35i_x + 15I_{SC} = 0$$

$$\Rightarrow \begin{cases} i = 4.88 \\ i_x = 3.90 \\ i_{SC} = \frac{1120}{123} \end{cases}$$

$$R_{th} = \frac{v_{th}}{i_{sc}} =$$