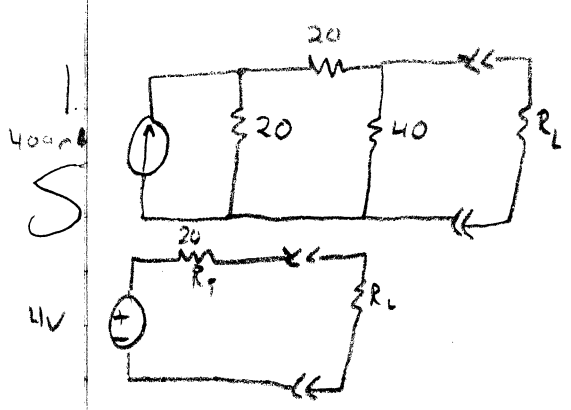
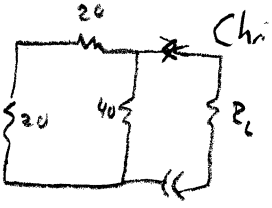
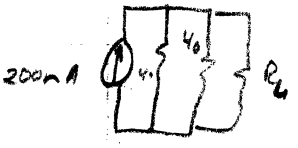
Hw #6 (22)

1.

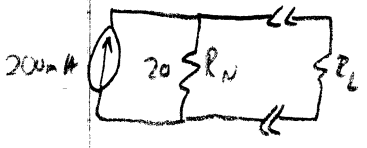




Chris Kerr TA



$\frac{40 \cdot 40}{80} = 20\Omega$

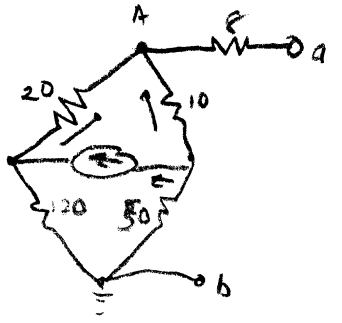


A. $R_T = R_L = 20\Omega$ $\quad P_{max} = \frac{i_N^2 R_T}{4} = \frac{.2^2 \cdot 20}{4} = 0.2\,W$

B. $R_L \to \infty$ $\quad V_{max} = V_T = 4V$

C. $R_L = 0$ $\quad i_{max} = \frac{V_T}{R_T} = \frac{4}{20} = 200\,mA$

2



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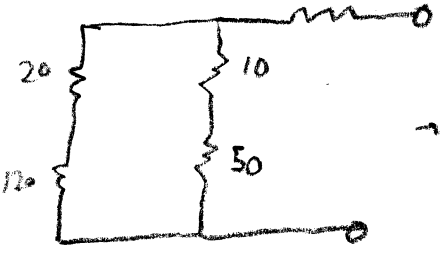
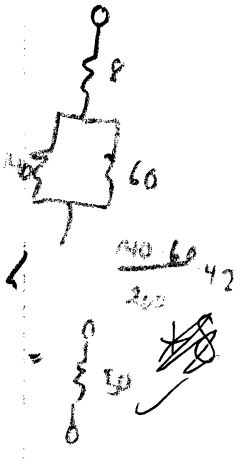




P_{max} @ Son - R_L

V_{open} A. $\frac{V_B - V_A}{20} + \frac{V_C - V_A}{10} = 0$

B. $-\frac{V_B - V_A}{20} + 2A + \frac{V_B}{120} = 0$

C. $-\frac{V_C - V_A}{10} + \frac{V_C}{50} - 2A = 0$

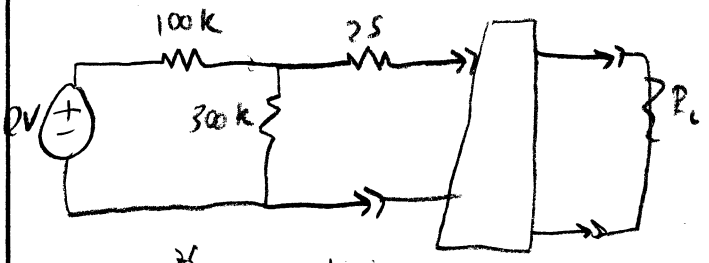
$V_A = 20V = V_0$
$V_B = 360\,V$
$V_C = 150\,V$

I_{sc} A. $\frac{V_B - V_A}{20} + \frac{V_C - V_A}{10} - \frac{V_A}{R} = 0$

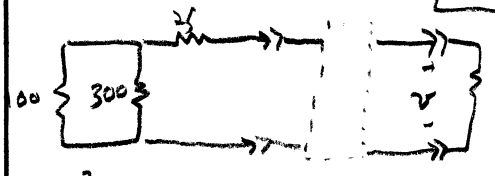
$V_A = 16/5$

$I_{sc} = \frac{V_A}{R} = \frac{16/5}{R} = 4\,A$ $\quad P_{max} = \left(\frac{I_{sc}}{2}\right)\left(\frac{V_{oc}}{2}\right) = \left(\frac{4}{2}\right)\left(\frac{20}{2}\right) = 2\,W$

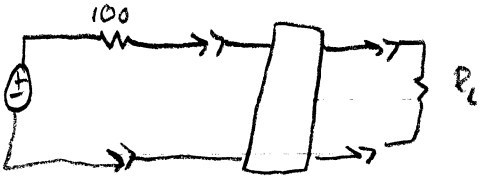
3. 5



$P_{max} = \left(\frac{V_{oc}}{2}\right)\left(\frac{I_{sc}}{2}\right) \leq .001\,W$



$\frac{100 \cdot 300}{400} = 75\,k\Omega$

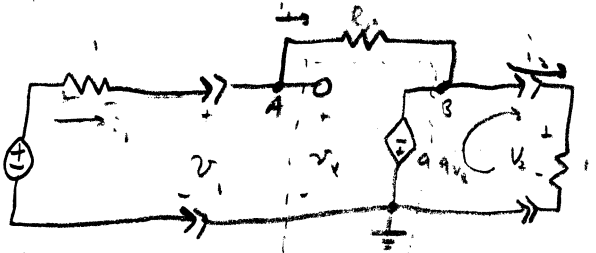


$P_{max} = \frac{V_r^2}{4R} = \frac{9^2}{4(100)} \leq .001\,W$

$2.025 \times 10^{-4}\,W \leq .001\,W$

- power is below indicated power resister of value 0 will work

4.



V_S

$i_1 = i_F$ $\quad i_1 = \frac{V_S - V_x}{1k\Omega} = \frac{V_x - V_F}{R_F} = F$

$V_B = V_2$ $\quad$ KVL @ $9V_x + V_2 = 0$

$V_x = \frac{-V_2}{9}$

$V_S = 10mV$ $\quad \frac{10mV + V_2/9}{1k\Omega} = \frac{-V_2/9 - V_2}{10k\Omega}$ $\quad i_2 = V_2/1k$

$R_F = 10k\Omega$

A $\quad 10mV + V_2/9 = 1/10\left(\frac{-100V_2}{9}\right) = -10V_2/9$

$10mV = -110V_2/9$

$-90V = -110V_2$

$\boxed{-9mV = V_2}$

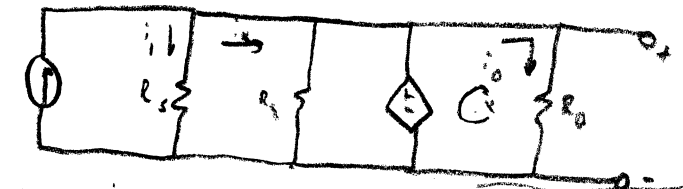
$i_1 = \frac{10mV - (-9mV)/9}{1k\Omega} \approx 0.01mA$

$i_2 = \frac{-9mV}{1k\Omega} = -0.009mA$

$\boxed{i_2/i_1 = -0.9}$ ✗

B. $R_{in} = \frac{V_1}{i_1} = \frac{-V_2/9}{.01mA} = \frac{\frac{9mV}{9}}{.01mA} = 90\Omega$ ✗

5



$KVL: -ri_x + i_0 R_0 = 0$

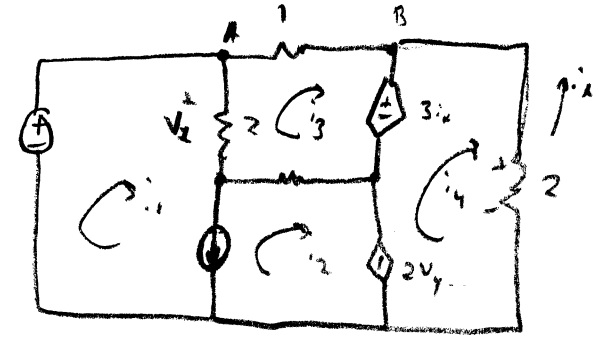
$i_s = i_1 + i_x$

$i_s = V_0/R_s + i_x$

Gain i_0/i_s $\quad i_0 = \frac{r i_x}{R_0}$

$$\frac{i_0}{i_s} = \frac{\frac{r i_x}{R_0}}{\frac{V_0}{R_s} + i_x}$$

6.



$i_1 - i_2 = 9A \quad V_y = i_1 - i_3$

$i_4 - i_2 = 2V_y = 4(i_1 - i_3)$

$-4i_1 - i_2 + 4i_3 - i_4 = 0$

Loop #: $-x + 4i_3 + 2i_4 = 2$

$i_x = -i_4$

$2V_y = V_c \quad -2(i_1 - i_3) + i_3 + 3i_x + 1(i_3 - i_4) = 0$

$-2i_1 + 2i_3 - i_2 + 2 + 3i_x = 0$

$-2i_1 - i_2 + 4i_3 + 3i_x = 0 \rightarrow 2i_1 - i_2 - 3i_4 = 0$

$2i_1 - i_2 + 4i_3 - 3i_4 = 0$

$i_1 - i_2 = 9$

$-4i_1 - i_2 + 4i_3 + i_x = 0$

$i_3 + 2i_4 = 2V$

$$\begin{bmatrix} 1 & -1 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_x \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 0 \\ 9 \\ 0 \\ 2 \end{bmatrix}$$

$i_1 = 2$

$i_2 = -7$

$i_3 = 0$

$i_4 = 1$

Node Voltage $V_B = 2i_x$

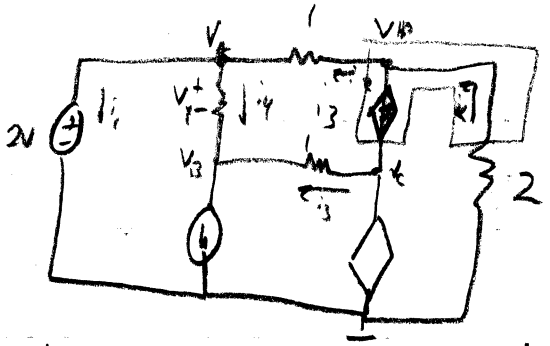
$V_A = -2V = V_{s1}$

$V_A - V_B = V_4$

$V_B - 2V_B + 2V_A - \frac{1}{2}V_D = 0$

$\frac{1}{2}V_A - \frac{3}{2}V_B - V_C = 9$

$V_C - \frac{1}{2}V_D = 0$



A. $-1(V_B - V_C) + 2(V_A - V_B) - \frac{1}{2}V_D = 1(V_A - V_B)$

B. $\frac{1}{2}(V_A - V_B) = 9 + 1(V_B - V_C)$

C. $V_D = V_C + 3i_x$

$i_x = V_D/2 \qquad V_D = V_C + \frac{3}{2}V_D$

$V_B - V_C + 2V_A - 2V_B - \frac{1}{2}V_D + V_A - V_B = 0$

$2V_A + V_A - V_B - 2V_B + V - \frac{3}{2}V_D$

A. $3V_A - 3V_B + V_C - \frac{3}{2}V_D = 0$

$-V_B - \frac{1}{2}V_D = -6$

$-\frac{3}{2}V_B + V_C = 9$

$V_C - \frac{1}{2}V_D = 0$

$V_C = 2V \qquad V_B = -2V$

$V_B = 4V \qquad V_D = 3V$

$i_x = -2A \qquad V_D = 6V$

B. $\frac{1}{2}V_A - \frac{1}{2}V_A - V_B + V_C = 9$

$\frac{1}{2}V_A - \frac{3}{2}V_B + V_C = 9$

C. $V_D - \frac{3}{2}V_D - V_C = 0$

$-\frac{1}{2}V_D - V_C = 0$

A. $-6 = 3V_B - V_C + \frac{3}{2}V_D$

B. $9 = \frac{3}{2}V_B - V_C$

C. $0 = -\frac{1}{2}V_D - V_C$

$i_x = 1A$

$$\begin{bmatrix} 3 & -1 & 1.5 \\ 3/2 & -1 & 0 \\ 0 & -1 & -.5 \end{bmatrix} \begin{bmatrix} \quad \end{bmatrix} = \begin{bmatrix} -6 \\ 9 \\ 0 \end{bmatrix}$$

$V_B = 8.66 \rightarrow V_C = 5V \qquad V_D = -10V$

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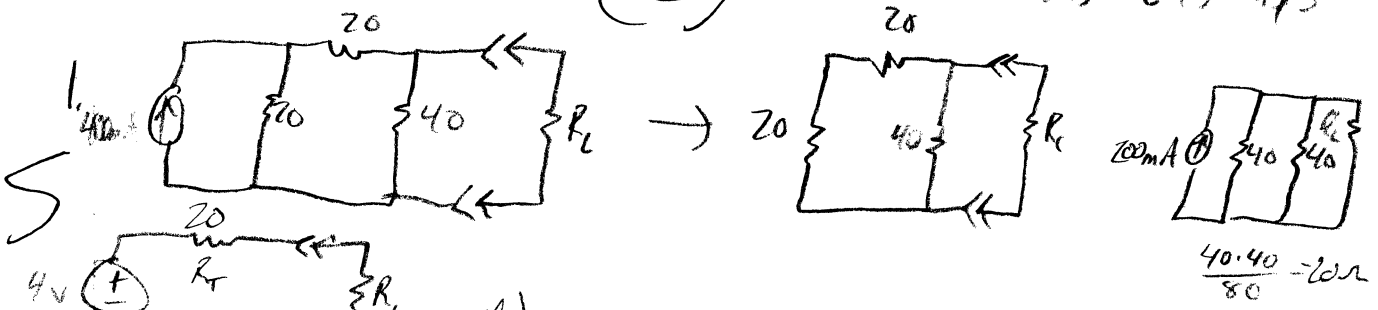
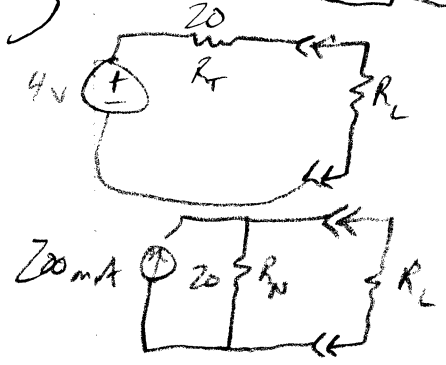
Tues: 245 4/5

(21)





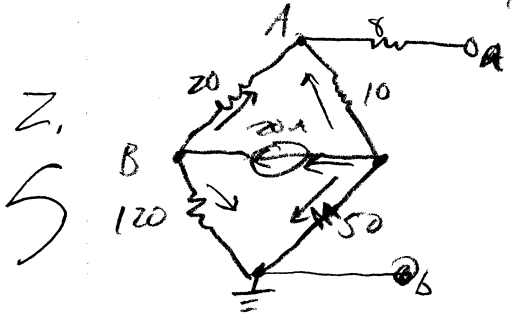
A) $R_T = R_L = 20\Omega$

$P_{max} = \frac{I_N^2 R_T}{4} = \frac{(.2)^2 20}{4} = 0.2W$

B) $R_L \to \infty \quad V_{max} = V_T = 4V$

C) $R_L = 0 \quad I_{max} = \frac{V_T}{R_T} = \frac{4}{20} = 200mA$

2.



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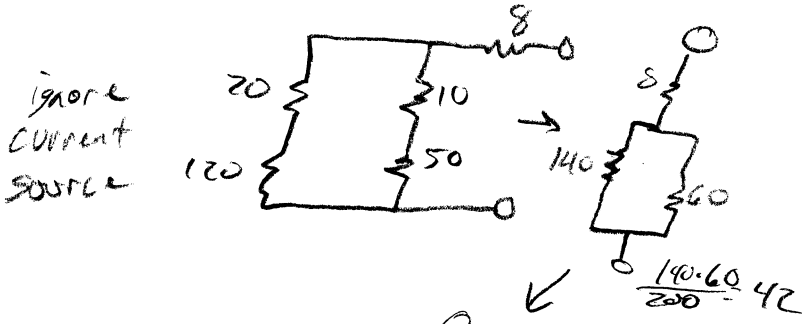


V_{open}

Node A: $\frac{V_B - V_A}{20} + \frac{V_C - V_A}{10} = 0$

B: $-\frac{V_B - V_A}{20} + 20A - \frac{V_B}{120} = 0$

C: $-\frac{V_C - V_A}{10} - \frac{V_C}{50} - 20A = 0$

Mathematica

$V_A = 20V - V_{oc}$

$V_B = 360V$

$V_C = -150V$

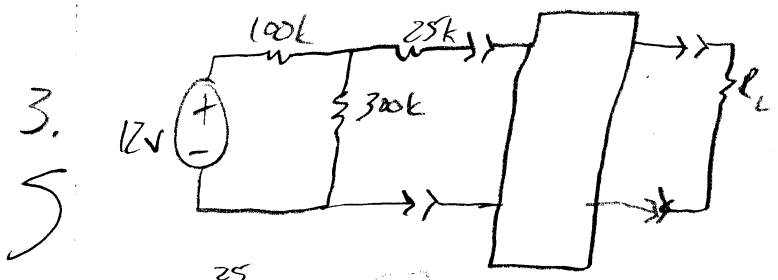
(I_{sc}) Node A: $\frac{V_B - V_A}{20} + \frac{V_C - V_A}{10} - \frac{V_A}{4} = 0$

$V_A = \frac{16}{5} V$

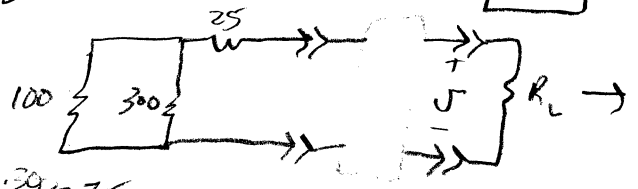
$I_{sc} = \frac{V_A}{16} = \frac{\frac{16}{5}}{8} = .4A$

$P_{max} = \left(\frac{I_{sc}}{2}\right)\left(\frac{V_{oc}}{2}\right) = \frac{.4}{2}\left(\frac{20}{2}\right) = 2W$

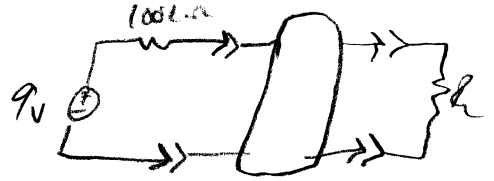
3.

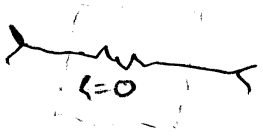


$P_{max} = \left(\frac{V_{oc}}{2}\right)\left(\frac{I_{sc}}{2}\right) \leq .001W$



$\frac{100 \cdot 300}{400} = 75\,k\Omega$



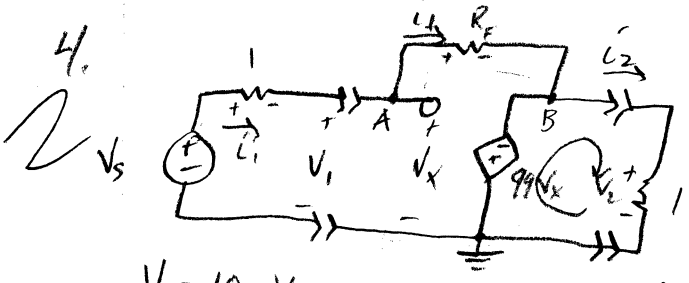


$P_{max} = \frac{V_t^2}{4R_t} = \frac{9^2}{4(100)} \leq .001W$

$2.025 \times 10^{-4} W \leq 1 \times 10^{-3} W$

Max power is below specified power so resistor with resistance of 0 works.

4.



$i_1 = i_F$ $\quad i_1 = \frac{V_S - V_x}{1k\Omega} = \frac{V_1 - V_S}{R_F} = i_F$

$V_B = V_2$ $\quad$ KVL: $99V_x + V_2 = 0$

$V_x = \frac{-V_2}{99}$

$V_S = 10mV$

$R_F = 10k\Omega$

$\frac{10mV + \frac{V_2}{99}}{1k\Omega} = \frac{-\frac{V_2}{99} - V_2}{10k\Omega}$

$i_2 = \frac{V_2}{1k}$

A) $10mV + \frac{V_2}{99} = \frac{1}{10}\left(\frac{-100V_2}{99}\right) = \frac{-10V_2}{99}$

$10mV = \frac{-110V_2}{99}$

$.99V = -110V_2$

$\boxed{-9mV = V_2}$

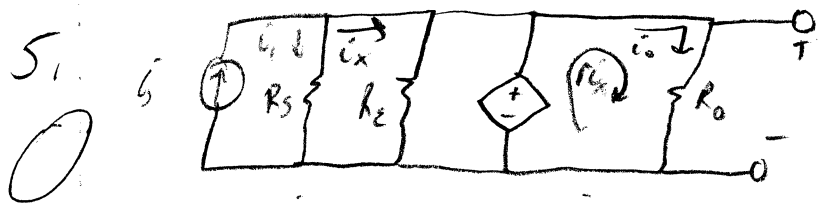
$i_1 = \frac{10mV - \frac{-9mV}{99}}{1k\Omega} \approx 0.01mA$

$i_2 = \frac{-9mV}{1k\Omega} = -0.009mA$

$\boxed{i_2/i_1 = -0.9}$ ✗

B) $R_{IN} = \frac{V_1}{i_1} = \frac{-V_2}{\frac{99}{.01mA}} = \frac{9mV}{.01mA} \approx \boxed{9.0\Omega}$ ✗

5.



KVL $\quad -ri_x + i_o R_o = 0$

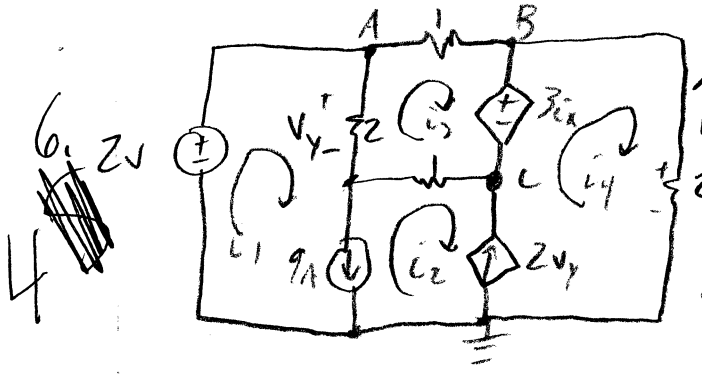
$i_s = i_1 + i_x$

$i_s = \frac{v_o}{R_s} + i_x$

$gain = \frac{i_o}{i_s}$ $\qquad i_o = \frac{r i_x}{R_o}$

$$\frac{\frac{i_o}{i_s}}{\frac{r i_x}{R_o}} = \frac{\frac{v_o}{R_s} + i_x}$$

6. 2V



$i_1 - i_2 = g_A$ $\qquad V_y = i_1 - i_3$

$i_4 - i_2 - 2V_y = 4(i_1 - i_3)^2$

$-4i_1 - i_2 + 4i_3 + i_4 = 0$

Lago A: $-x+1 \quad i_3 + 2i_4 = 2$

$i_x = -i_x$

$2V_y = V_c$

$-2(i_1 - i_3) + 1i_3 + 3i_x + 1(i_3 - i_2) = 0$

$-2i_1 + \cancel{2i_3} + \cancel{2i_3} - i_2 + 3i_x = 0$

$-2i_1 - i_2 + 4i_3 + 3i_x = 0 \longrightarrow 2i_1 - i_2 - 3i_4 = 0$

$$\begin{cases} 2i_1 - i_2 + 4i_3 - 3i_4 = 0 \\ i_2 - i_2 = g \\ -4i_1 - i_2 + 4i_3 + i_4 = 0 \\ i_3 + 2i_4 = 2V \end{cases}$$

$$\begin{bmatrix} 1 & -1 & 0 & 0 \\ -4 & -1 & 4 & 1 \\ 0 & 0 & 1 & 2 \\ -2 & -1 & 4 & -3 \end{bmatrix} \begin{bmatrix} i_1 \\ i_2 \\ i_3 \\ i_4 \end{bmatrix} = \begin{bmatrix} 0 \\ g \\ 0 \\ 2 \end{bmatrix}$$

$i_1 = 2$

$i_2 = -7$

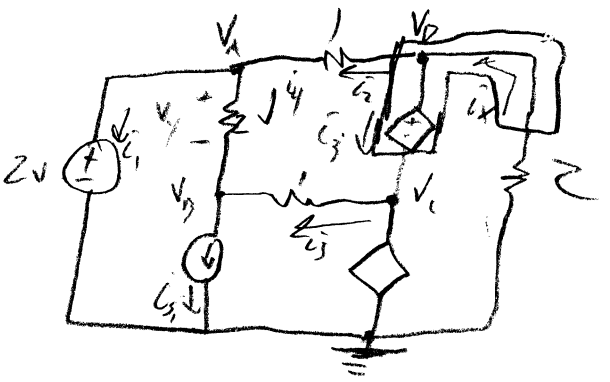
$i_3 = 0$

$i_4 = 1$

Node Voltage $V_B = 2i_x$

$V_A = -2V = V_1$

$V_A - V_B = V_y$



$V_B - 2V_B + 3V_A - \frac{1}{2}V_D = 0$

$\frac{1}{2}V_A - \frac{3}{2}V_B - V_C = 9$

$V_C - \frac{1}{2}V_D = 0$

$-V_D - \frac{1}{2}V_B = -6$

$-\frac{3}{2}V_B - V_C = 8$

$V_C - .5V_D = 0$

$V_C = 2.0V$ $V_B = -2.8$

$V_A = -4.8V$ $V_C = 3.4$

$i_x = -2.4A$ $V_D = 6.8$

(A) $-1(V_B - V_C) + 2(V_A - V_B) - \frac{1}{2}V_D + 1(V_A - V_B) = 0$

(B) $\frac{1}{2}(V_A - V_B) = 9 + 1(V_B - V_C)$

(C) $V_D = V_C + 3i_x$

$i_x = \frac{V_A}{2}$

$V_D = V_C + \frac{3}{2}V_A$

$V_B - V_C + 2V_A - 2V_B - \frac{1}{2}V_D + V_A - V_B = 0$

$2V_A + V_A - V_B - 2V_B + V - \frac{3}{2}V_D$

(A) $3V_A - 3V_B + V_C - \frac{3}{2}V_D = 0$

(B) $\frac{1}{2}V_A - \frac{1}{2}V_B - V_B + V_C = 9$

$\frac{1}{2}V_A - \frac{3}{2}V_B + V_C = 9$

(C) $V_D - \frac{3}{2}V_D - V_C = 0$

$-\frac{1}{2}V_D - V_C = 0$

(A) $-6 = 3V_B - V_C + \frac{3}{2}V_D$

(B) $-8 = \frac{3}{2}V_B - V_C$

(C) $0 = -\frac{1}{2}V_D - V_C$

$\begin{bmatrix} 3 & -1 & 1.5 \\ \frac{3}{2} & -1 & 0 \\ 0 & -1 & -.5 \end{bmatrix} \begin{bmatrix} \quad \\ \quad \\ \quad \end{bmatrix} = \begin{bmatrix} 6 \\ -8 \\ 0 \end{bmatrix}$

$i_x = 7A$

$V_B = 8.667$ ✓

$V_C = 5V$

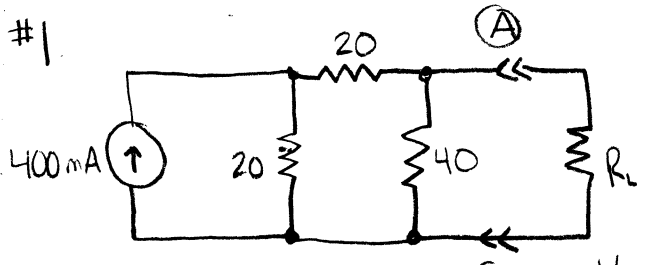
$V_D = -10V$

27/30 Very Good

Engr 210

Danielle Henkel
2-23-05 WA

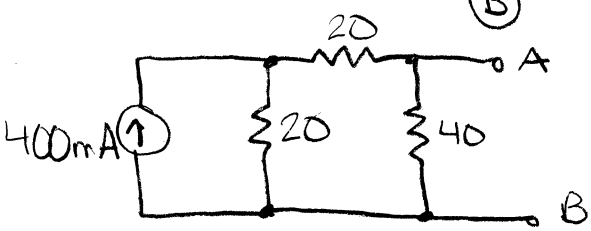
#1

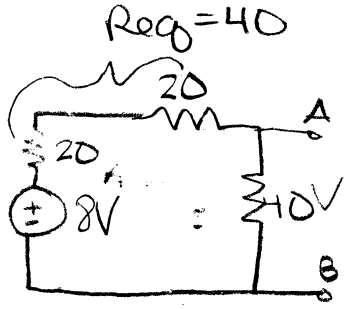


B

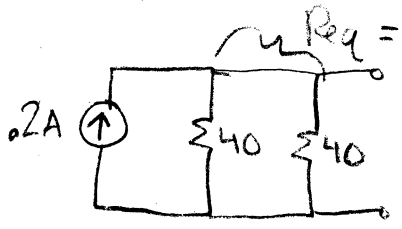
$V = IR$

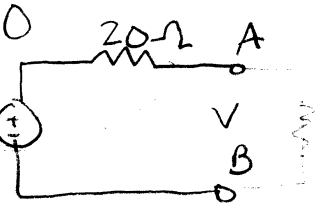
(+5)





$I = V/R$





$R_T = 20\,\Omega = R_L$

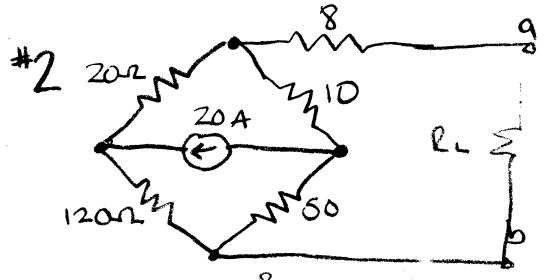
$V_T = 4V$

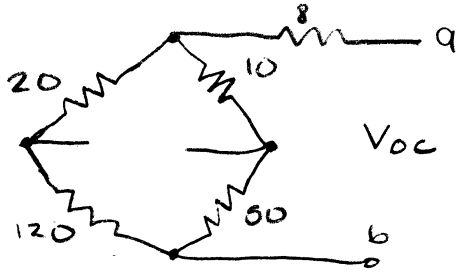
a) $P_{max} = \frac{V_T^2}{4R_T} = \frac{4^2}{4(20)} = .2\,W$

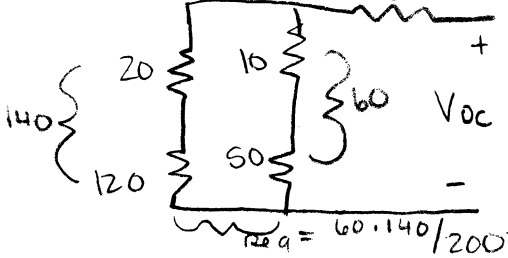
b) V_{max} when $R_L = \infty$ so $V_{max} = V_{oc} = V_T = 4V$

c) i_{max} when $R_L = 0$ $i_{max} = \frac{V_T}{R_T} = \frac{4}{20} = .2\,A$

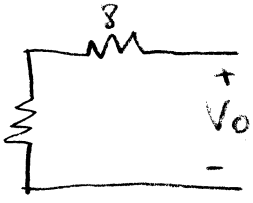
#2

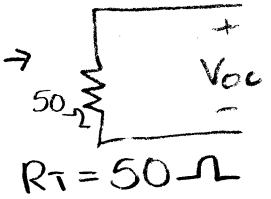






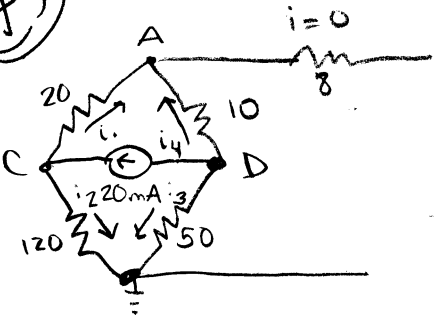
$R_{eq} = 60 \cdot 140/200 = 42$





$R_T = 50\,\Omega$

(#4)



KCL:

A: $i_1 + i_4 = 0$

C: $-i_1 - i_2 + i_5 = 0$

D: $-i_4 + i_3 - i_5 = 0$

A: $\frac{V_C - V_A}{20} + \frac{V_D - V_A}{10} = 0$ $\quad \frac{V_C - V_A}{20} = -\frac{V_D - V_A}{10}$

C: $-\frac{(V_C - V_A)}{20} - \frac{V_C}{120} + 20mA = 0$ $\quad V_C - V_A = -2V_D - 2V_A$

$V_C + V_A = V_D$

D: $-\frac{(V_D - V_A)}{10} - \frac{V_D}{50} - 20mA = 0$

$-20mA = \frac{V_D - V_A}{10} + \frac{V_D}{50}$

$-20mA = \frac{V_D}{10} - \frac{V_A}{10} + \frac{V_D}{50}$

$\frac{V_A}{10} - 20 = \frac{V_D}{10} + \frac{V_D}{50}$

$\frac{V_A}{10} - 20 = V_D\left(\frac{1}{10} + \frac{1}{50}\right)$

$\frac{V_A}{10} - 20 = .12V_D$

$\frac{.1V_A - 20}{.12} = V_D$

$\frac{V_D + V_C}{120} - \frac{V_C}{20} + 20 = 0$

$\frac{V_D + V_C}{120} + 20 = \frac{V_C}{20}$

$\frac{V_D}{120} + \frac{V_C}{120} + 20 = \frac{V_C}{20}$

$\frac{V_D}{120} + 20 = V_C\left(\frac{1}{20} - \frac{1}{120}\right)$

$\frac{V_D}{120} + 20 = \frac{1}{24}V_C$

$.2V_D + 480 = V_C$

$\frac{5}{6}V_A - \frac{500}{3} = V_D = V_C + V_A$

$-\frac{1}{6}V_A - \frac{500}{3} = V_C$

$-\frac{V_A}{6} = V_C + \frac{500}{3}$

$-V_A = 6V_C + 1000$

$V_A = -6V_C - 1000$

$V_A = -6(.2V_D + 480) - 1000$

$V_A = -1.2V_D - 2880 - 1000$

$V_A = -1.2V_D - 3880$

$V_D = (-1.2V_D - 3880) + (.2V_D + 480)$

$V_D = -V_D - 3400$

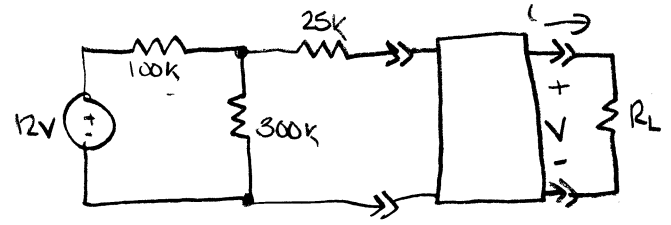
$2V_D = -3400$

$V_D = -170V = V_{OC} = V_T$ OK

$P_{max} = \frac{V_T^2}{4R_T} = \frac{-170^2}{4(50)} = 144.5W$

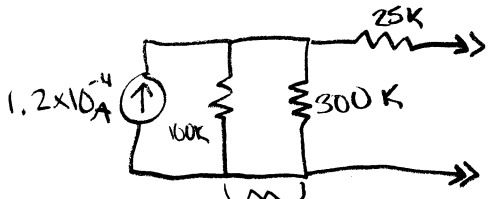
$R_L = R_T = 50\Omega$

15

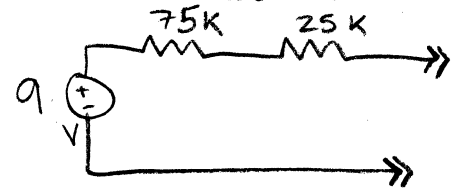
3. 

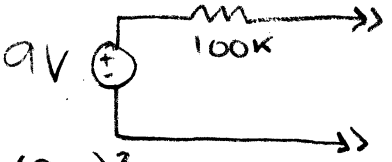
$P < 1mW$

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



$R_{eq} = \frac{100K \cdot 300K}{100K + 300K} = \frac{30000K}{400K} = 75K$

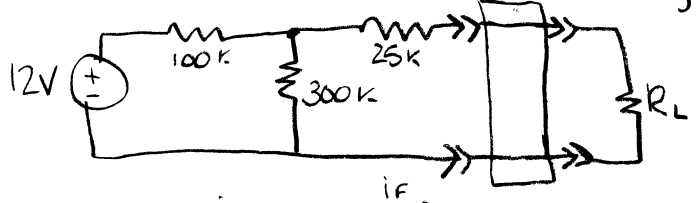


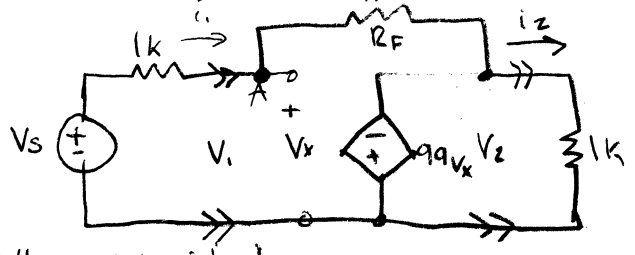


$R_T = 100K$ $\quad V_T = 9V$ $\quad \frac{V_T^2}{4R_T} = P_{max}$ $\quad \frac{(9V)^2}{4(100K)} = 2.026 \times 10^{-4} W$

$P_{max} = 2.025 \times 10^{-4} W$ is always less than 1mW

so interface circuit can just be two wires



4. 

$i_1 = i_F$

KVL right side:

$99V_x + V_2 = 0$

$V_x = -\frac{V_2}{99}$

15

a) $V_S = 10mV$ $\quad R_F = 10K\Omega$

$$\frac{V_S - V_X}{1K} = \frac{V_X - V_2}{R_F} \qquad 99V_X + V_2 = 0$$

$$V_X = -V_2/99$$

$$\frac{V_S + (V_2/99)}{1K} = \frac{-V_2/99 - V_2}{R_F}$$

$$V_S + \frac{V_2}{99} = 1000\left(\frac{-V_2/99 - V_2}{R_F}\right)$$

$$10mV + \frac{V_2}{99} = 1000\left(\frac{-V_2/99 - V_2}{10K}\right)$$

$$10mV + \frac{V_2}{99} = \frac{-V_2/99 - V_2}{10}$$

$$100mV + \frac{10V_2}{99} = -\frac{V_2}{99} - V_2$$

$$= -V_2\left(\frac{1}{99} + 1\right)$$

$$100mV + \frac{10V_2}{99} = -V_2(1.01)$$

$$100mV = -1.01V_2 - \frac{10V_2}{99}$$

$$100mV = \left(-1.01 - \frac{10}{99}\right)V_2$$

$$100mV = (-10/9)V_2$$

$$-.09 = V_2$$

$$i_2 = \frac{V_2}{1000\Omega} = \frac{-.09}{1000\Omega} = -9 \times 10^{-5} A$$

$$i_1 = \frac{V_S - V_X}{1000\Omega} = \frac{10mV - 9.09 \times 10^{-4} V}{1000} = 9.091 \times 10^{-6}$$

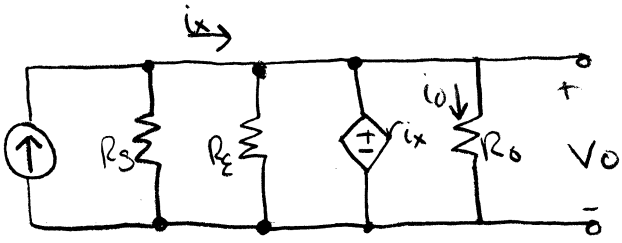
$$\frac{i_2}{i_1} = \frac{-9 \times 10^{-5} A}{9.091 \times 10^{-6}} = -9.899$$

4b) $R_{in} = \frac{V_1}{i_1}$ $\quad V_1 = V_x = 9.09 \times 10^{-4} V$

$i_1 = 9.091 \times 10^{-6} A$

$= \frac{9.09 \times 10^{-4} V}{9.091 \times 10^{-6}} = \boxed{99.98952\ \Omega}$

5)



$i_{gain} = \frac{i_o}{i_s}$

(X5)

$i_s = i_1 + i_x$, $i_1 = V_o/R_s$ $\Rightarrow$ $i_s = V_o/R_s + i_x$

$V_o = i_o R_o$

$-r i_x + V_o = 0$

$-r i_x + i_o R_o = 0$

$i_o R_o = r i_x$

$i_x = \frac{i_o R_o}{r}$

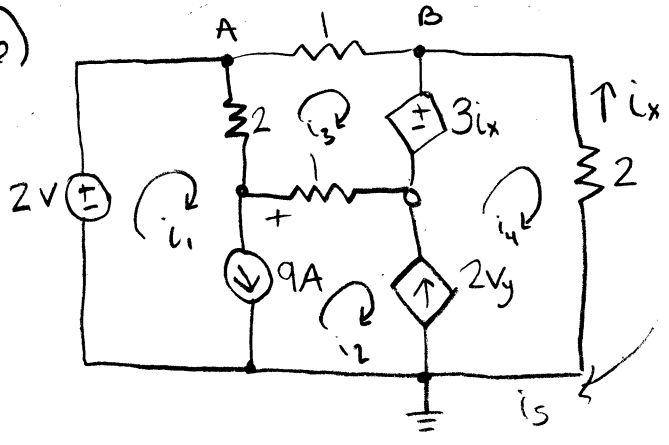
$i_s = \frac{V_o}{R_s} + \frac{i_o R_o}{r}$

$i_s = \frac{i_o R_o}{R_s} + \frac{i_o R_o}{r}$

$i_s = i_o \left(\frac{R_o}{R_s} + \frac{R_o}{r} \right) = \frac{R_o r}{R_s r} + \frac{R_o R_s}{R_s r}$

$\boxed{i_o = i_s \left(\frac{R_s \cdot r}{R_o (r + R_s)} \right)}$

6)



(+3)

a) $i_1 - i_2 = 9A$ (1)

$i_4 - i_2 = 2v_4$ (2)

$i_x = -i_4$

$V_c + 3i_x = 2i_4 \quad V_c = 2i_4 - 3i_x$

KVL:

$(i_3 - i_1)2 + i_3 \cdot 1 + 3i_x + (i_3 - i_2)1 = 0$ (3)

$-2 + i_3(1\Omega) + i_4(2\Omega) = 0$ (4)

$2i_3 - 2i_1 + i_3 + 3i_x + i_3 - i_2 = 0$

$4i_3 - 2i_1 + 3i_x - i_2 = 0$

$4i_3 + 3i_x - 2i_1 - i_2 = 0$

$4i_3 + -3i_4 - 2i_1 - i_2 = 0$

$v_4 = (i_1 - i_3)R$

$i_4 - i_2 = 2(i_1 - i_3)2$

$i_4 - i_2 = 4i_1 - 4i_3$

$i_3 + 2i_4 = 2V \quad i_3 = 2V - 2i_4$

$i_1 = i_2 + 9A$

$i_4 + 4i_3 = 4i_1 + i_2$

$4i_3 = 3i_4 + 2i_1 + i_2$

$i_4 + 3i_4 + 2i_1 + i_2 = 4i_1 + i_2$

$4i_4 = 2i_1$

$2i_4 = i_1$

$4i_3 = 3i_4 + 4i_4 + i_2$

$4i_3 = 7i_4 + i_2$

$4(2V - 2i_4) = 7i_4 + i_2$

$8V - 8i_4 = 7i_4 + i_2$

$8V = 15i_4 + i_2$

$i_3 + 2i_4 = 2$

$i_1 - i_2 = 9$

$4i_1 + i_2 - 4i_3 - i_4 = 0$

$2i_1 + i_2 - 4i_3 + 3i_4 = 0$

$i_1 = 2A$

$i_2 = -7$

$i_3 = 0$

$i_4 = 1$

$$A = \begin{bmatrix} 0 & 0 & 1 & 2 \\ 1 & -1 & 0 & 0 \\ 4 & 1 & -4 & -1 \\ 2 & 1 & -4 & 3 \end{bmatrix} \quad (4 \times 4)$$

$$B = \begin{bmatrix} 2 \\ 9 \\ 0 \\ 0 \end{bmatrix} \quad (4 \times 1)$$

$A^{-1} B = Ans$

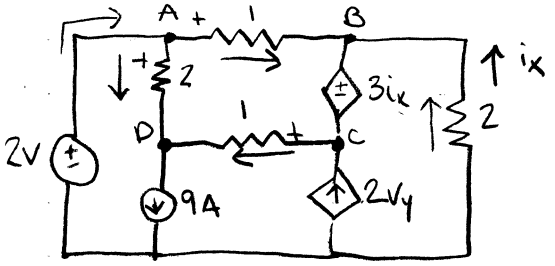
$i_x = -1A$

$V_c = 2(1) - 3(-1)$

$V_c = 2 + 3 = 5V$

b) $V_A = 2V$

$V_B = V_C + 3i_x$ $\quad 3i_x = V_B - V_C$



A: $(2 - V_A) - \frac{(V_A - V_D)}{2} - \frac{V_A - V_B}{1} = 0$

B: $3i_x + \frac{(V_A - V_B)}{1} + i_x = 0 = V_B - V_C + \frac{(V_A - V_B)}{1} + \frac{V_B - V_C}{3}$

C: $-3i_x - \frac{(V_C - V_D)}{1} + 2v_y = 0 = -(V_B - V_C) - \frac{(V_C - V_D)}{1} + \frac{(V_A - V_D)}{2}$

D: $-9 + \frac{V_C - V_D}{1} + \frac{V_A - V_D}{2} = 0$

A: $2 - V_A - \frac{V_A}{2} + \frac{V_D}{2} - V_A + V_B = 0$ $\quad \frac{5}{2}V_A - V_B - \frac{V_D}{2} = 2$

B: $V_B - V_C + V_A - V_B + \frac{V_B}{3} - \frac{V_C}{3} = 0$ $\quad V_A + \frac{V_B}{3} - \frac{4}{3}V_C = 0$

C: $-V_B + V_C - V_C + V_D + V_A - V_D = 0$ $\quad V_A - V_B + V_D = 0$

D: $-9 + V_C - V_D + \frac{V_A}{2} - \frac{V_D}{2} = 0$ $\quad \frac{V_A}{2} + V_C - \frac{3}{2}V_D = 9$

$$\begin{bmatrix} 5/2 & -1 & 0 & -1/2 \\ 1 & 1/3 & -4/3 & 0 \\ 1 & -1 & 0 & 1 \\ 1/2 & 0 & 1 & -3/2 \end{bmatrix} \begin{bmatrix} 2 \\ 0 \\ 0 \\ 9 \end{bmatrix} = \begin{bmatrix} 29\,1/3 \\ 57\,1/3 \\ 36\,1/3 \\ 28 \end{bmatrix} \begin{matrix} V_A \\ V_B \\ V_C \\ V_D \end{matrix}$$

You said $V_A = 2V$ above. −1

$3i_x = V_B - V_C$

$V_C = V_A - V_B + V_D = 0$

$= 29\,1/3 - 57\,1/3 + 28$

$V_C = 0$

$57\,1/3 - 36\,1/3$

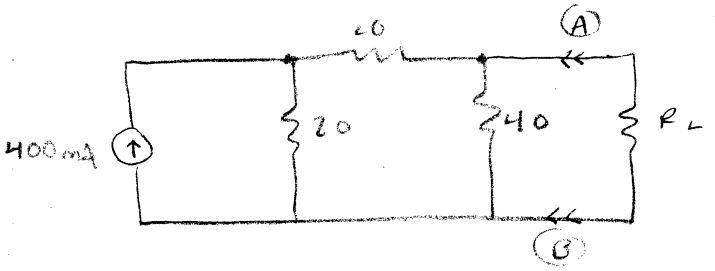
$i_x = 7$ −1

Barbie Baran
2-23-05
Circuits WA

Very Nice! 27/30

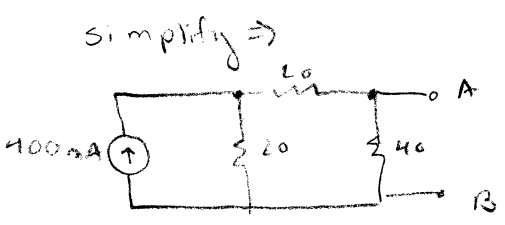
Circuits HW #6

1.)

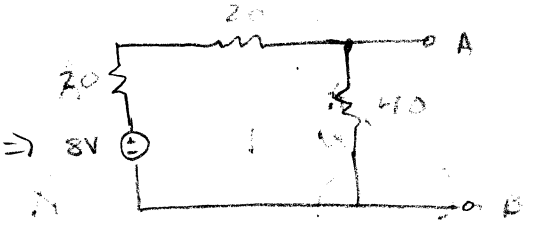


+5

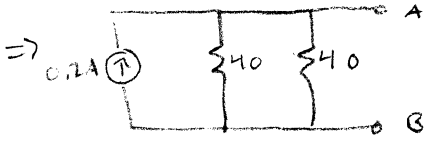
Simplify ⇒



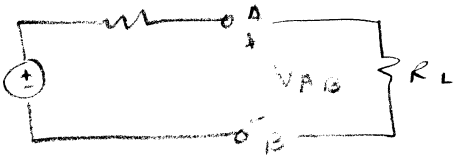
⇒



⇒



⇒



$R_T = 20\,\Omega = R_L$

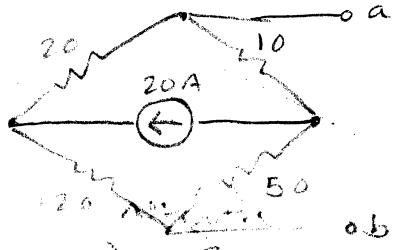
$V_T = 4.0\,V$

a.) $P_{max} = \frac{V_T^2}{4R_T} = \frac{(4.0)^2}{4(20)} = \boxed{0.2\,W}$

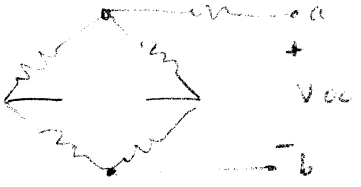
b.) $V_{max} = R_L = \infty$ ∴ $V_{max} = V_\infty = \boxed{V_T = 4V}$

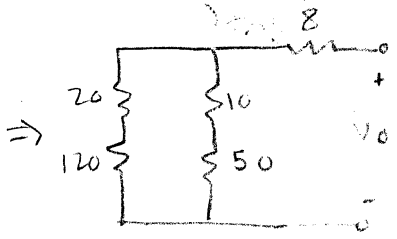
c.) $I_{max} = R_L = 0$; $i_{max} = V_T/R_T = 4/20 = \boxed{0.2\,A}$

2.)

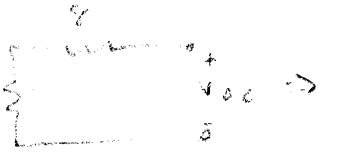


open circuit ⇒

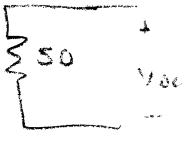




⇒

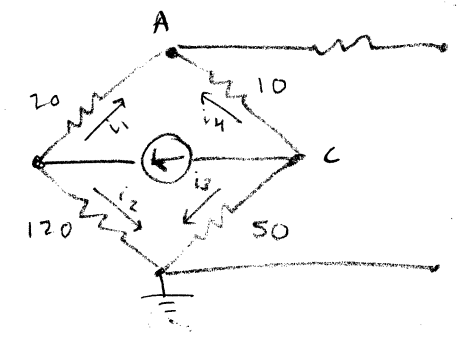


⇒



∴ $\boxed{R_T = 50\,\Omega} = \boxed{R_L}$

(4)



A. $i_1 + i_4 = 0$

B. $-i_1 - i_2 + i_3 = 0$

C. $-i_4 - i_3 - i_5 = 0$

A: $\frac{V_B - V_A}{20} + \frac{V_C - V_A}{10} = 0$; $\frac{V_B - V_A}{20} = -\frac{V_C - V_A}{10}$

B: $-\frac{(V_B - V_A)}{20} - \frac{V_B}{120} + 20\,mA = 0$ $\quad V_B - V_A = -2V_C - 2V_A$

$V_B + V_A = V_C$

C: $-\frac{(V_C - V_A)}{10} - \frac{V_C}{50} - 20\,mA = 0$

$-20\,mA = \frac{V_C - V_A}{10} + \frac{V_C}{50}$; $-20mA = \frac{V_C}{10} - \frac{V_A}{10} + \frac{V_C}{50}$

$\frac{V_A}{10} - 20 = V_C\left(\frac{1}{10} + \frac{1}{50}\right)$; $V_C = \frac{0.1V_A - 20}{0.12}$

$\frac{V_C + V_B}{120} - \frac{V_B}{20} + 20 = 0$; $\frac{V_B + V_C}{120} + 20 = \frac{V_B}{20}$; $\frac{V_C}{120} + \frac{V_B}{120} + 20 = \frac{V_B}{20}$

$\frac{V_C}{120} + 20 = V_B\left(\frac{1}{20} - \frac{1}{120}\right)$; $\frac{V_C}{120} + 20 = \frac{V_B}{24}$; $V_B = 0.2V_C + 480$

$5/6\,V_A - \frac{500}{3} = V_C = V_B + V_A$; $-\frac{V_A}{6} = V_B + \frac{500}{3}$; $V_A = -6V_C - 1000$

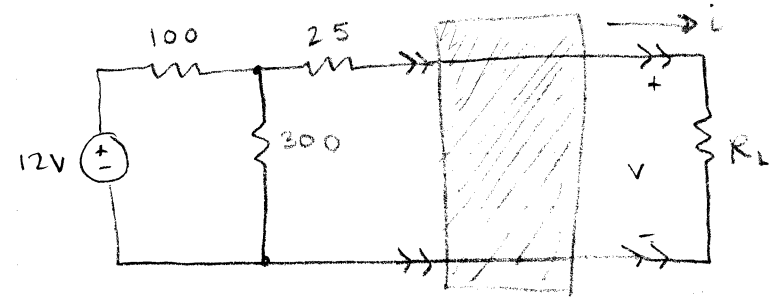
$V_A = -1.2V_C - 2880 - 1000 = -1.2V_C - 3880$

$V_C = (-1.2V_C - 3880) + (1.2V_C + 480) \Rightarrow \boxed{V_C = -170V = V_{OC} = V_T}$

$P_{max} = \frac{V_T^2}{4(R_T)} = \frac{(-170)^2}{(4)(50)} = \boxed{144.5\,W = P_{max}}$

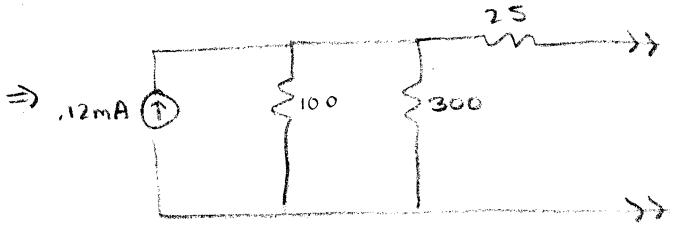
OK given error

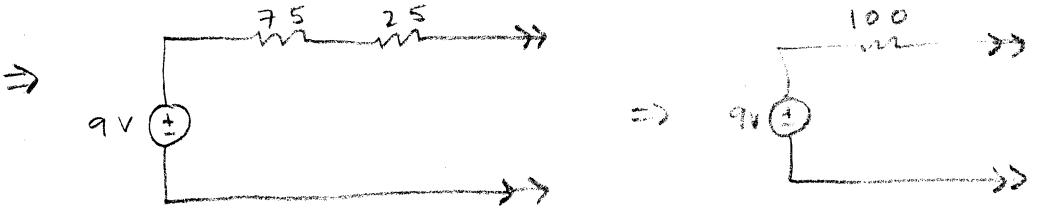
3



$P \leq 1\,mW$

+5



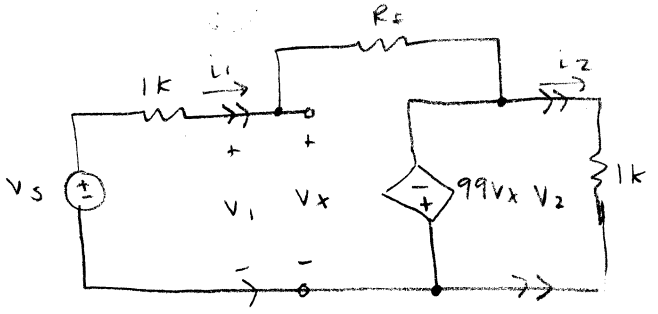


$\therefore R_T = 100k$, $V_T = 9V$

$P_{max} = \frac{V_T^2}{4R_T} = \frac{(9)^2}{4(100)} = \boxed{2.025 \times 10^{-4}\ W}$

$\therefore$ interfaced circuit can be wires

4.



$i_1 = i_F$

+5

KVL RIGHT $= 99V_x + V_2 = 0$; $V_x = -V_2/99$

a.) $V_S = 10\,mV$, $R_F = 10k\Omega$

$\frac{V_S - V_x}{1k} = \frac{V_x - V_2}{R_F}$; $\frac{V_S + (V_2/99)}{1k} = \frac{-\frac{V_2}{99} - V_2}{R_F}$

$V_S + \frac{V_2}{99} = 1000\left(\frac{-\frac{V_2}{99} - V_2}{R_F}\right)$; $10mV + \frac{V_2}{99} = 1000\left(\frac{-\frac{V_2}{99} - V_2}{100}\right)$

$10\,mV + \frac{V_2}{99} = \frac{-\frac{V_2}{99} - V_2}{10}$; $100\,mV + \frac{10V_2}{99} = -\frac{V_2}{99} - V_2 = -V_2\left(\frac{1}{99}+1\right)$

$100\,mV + \frac{10\,mV}{99} = -V_2(1.01)$; $100mV = -1.01V_2 - 10V_2/99$

$\Rightarrow$ $100\,mV = (-1.01 - 10/99)V_2$; $100\,mV = (-10/9)V_2$; $\boxed{V_2 = -0.09}$

$\boxed{i_2} = V_2/1000 = -.09/1000 = \boxed{-9.0\times10^{-5}\,A}$

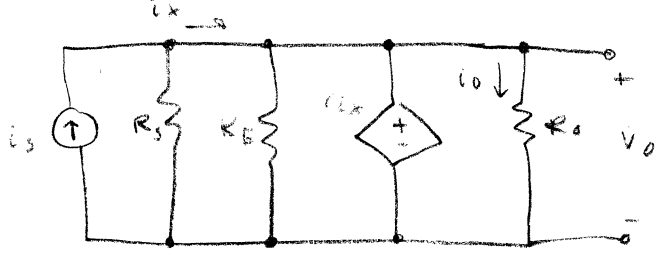
$\boxed{i_1} = \frac{V_S - V_x}{1000} = \frac{10\,mV - 9.09\times10^{-4}V}{1000} = \boxed{9.091\times10^{-6}\,A}$

$\therefore$ Gain $= i_2/i_1 = \frac{-9.0\times10^{-5}A}{9.091\times10^{-6}A} = \boxed{-9.899}$

b.) $R_{IN} = V_1/i_1$

$V_1 = V_x = 9.09\times10^{-4}V$; $i_1 = 9.091\times10^{-6}\,A$ $\Rightarrow$ $R_{IN} = \frac{9.09\times10^{-4}V}{9.091\times10^{-6}} = \boxed{99.99\,\Omega}$

5.)



GAIN $= \frac{i_o}{i_s}$

15

$i_o = i_1 + i_x$; $i_s = \frac{V_o}{R_s} + i_x$

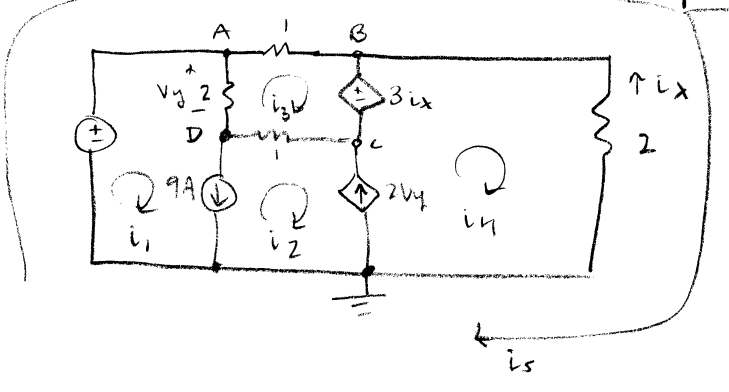
$i_1 = \frac{V_o}{R_s}$

$V_o = i_o R_o$; $-r\,i_x + V_o = 0$; $-r\,i_x + i_o R_o = 0$; $i_o R_o = r\,i_x$; $i_x = \frac{i_o R_o}{r}$

$i_s = \frac{V_o}{R_s} + \frac{i_o R_o}{r} \Rightarrow \frac{i_o R_o}{R_s} + \frac{i_o R_o}{r}$

$i_s = i_o\left(\frac{R_o}{R_s} + \frac{R_o}{r}\right) = \frac{R_o r}{R_s r} + \frac{R_o R_s}{R_s r}$; $\boxed{i_o = i_s\left[\frac{R_s \cdot r}{R_o(r + R_s)}\right]}$

6.



#3

a.) $i_1 - i_2 = 9A$ $\quad i_x = -i_4$

$i_4 - i_2 = 2v_y$ $\quad v_c + 3i_x = 2i_4$; $v_c = 2i_4 - 3i_x$

$2(i_3 - i_1) + i_3 + 3i_x + (i_3 - i_2) = 0$

$\boxed{-2 + i_3(1\Omega) + i_4(2\Omega) = 0}$

$2i_3 - 2i_1 + i_3 + 3i_x + i_3 - i_2 = 0$; $4i_3 - 2i_1 + 3i_x - i_2 = 0$

$\boxed{4i_3 + 3i_x - 2i_1 - i_2 = 0}$

$v_y = (i_1 - i_3)R$; $i_4 - i_2 = 2(i_1 - i_3)2$; $i_4 - i_2 = 4i_1 - 4i_3$

$i_3 + 2i_4 = 2v$; $i_3 = 2v - 2i_4$; $i_1 = i_2 + 9A$; $i_4 + 4i_3 = 4i_1 + i_2$

$i_4 + 3i_4 + 2i_1 + i_2 = 4i_1 + i_2 \Rightarrow 4i_4 = 2i_1$; $2i_4 = i_1$

$4i_3 = 3i_4 + 4i_4 + i_2$; $4i_3 = 7i_4 + i_2$; $4(2v - 2i_4) = 7i_4 + i_2$

$\Rightarrow 8v - 8i_4 = 7i_4 + i_2$; $8v = 15i_4 + i_2$

$\therefore i_1 - i_2 = 9$, $i_3 + 2i_4 = 2$; $4i_1 + i_2 - 4i_3 - i_4 = 0$,

$2i_1 + i_2 - 4i_3 + 3i_4 = 0$

using solver in calculator $\Rightarrow$

$i_1 = 2$

$i_2 = -7$

$i_3 = 0$

$i_4 = 1$

$i_x = \boxed{-1A}$

$v_c = (2)(1) - 3(-1) = \boxed{5V}$

Good

b.) $v_A = 2V$

$v_D = v_c + 3i_x$; $3i_x = v_D - v_c$

A: $(2 - v_A) - \left(\frac{v_A - v_D}{2}\right) - (v_A - v_B) = 0$

B: $3i_x + (v_A - v_B) + i_x = 0$; $v_B - v_c + (v_A - v_B) + \frac{(v_B - v_c)}{3}$

C: $-3i_x - (v_c - v_B) + 2v_y = 0 = -(v_B - v_c) - (v_c - v_D) + \frac{2(v_A - v_D)}{2}$

D: $-9 + (v_c - v_D) + \frac{v_A - v_D}{2} = 0$

simplified equations.

$2.5V_A - V_B - 0.5V_D = 2$

$V_A - .3V_B - 1.3V_C = 0$

$V_A - V_C + V_D = 0$

$0.5I_A + V_C - 1.5V_D = 9$

use solver in calculator

$V_A = 29\frac{1}{3}$ V

$V_B = 57\ 1/3$ V

$V_C = 36\ 1/3$ V

$V_4 = 28$ V

$V_A = 2$ V

$V_C = V_A - V_B + V_D = 0$

$= 29\frac{1}{3} - 57\frac{1}{3} + 28 = 0 = V_C$

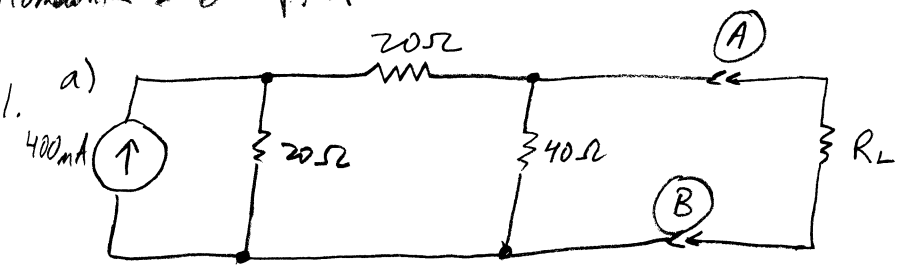
$3.5A = V_D - V_C = 57\frac{1}{3} - 36\frac{1}{3} = 7 = 7$ ✓

Answers will match part a)

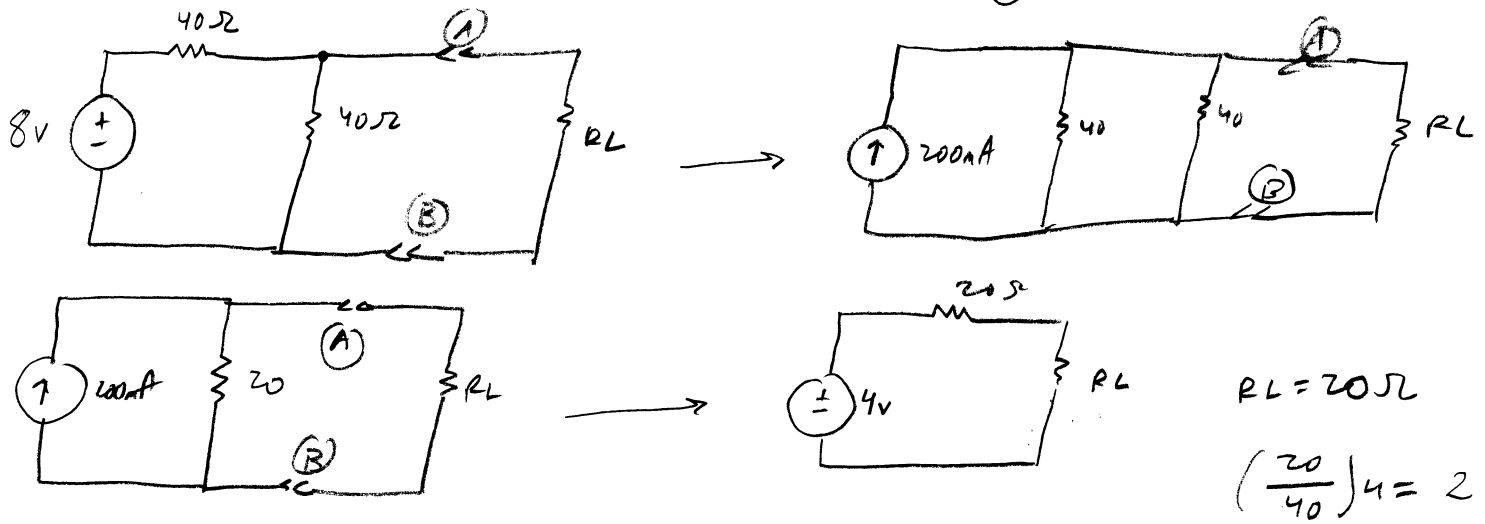
Joseph L. Barone
Homework #6 Prof A

$\frac{26}{30}$ Good Job!

1. a)



+5



$R_L = 20\Omega$

$\left(\frac{20}{40}\right)4 = 2V$

$V_{R_L} = 2V$

$\left(\frac{20}{40}\right)200 = 100mA$

$i = 0.1A$ $\quad v = \left(\frac{20}{20}\right)4 = 2V$ $\quad \boxed{R_L = 20\Omega}$

$i_{max} = \frac{4V}{20\Omega} = 0.2A = 200mA = i_N$

$\boxed{P_{max} = \frac{v_T i_N}{4} = 0.2 \text{ Watts}}$

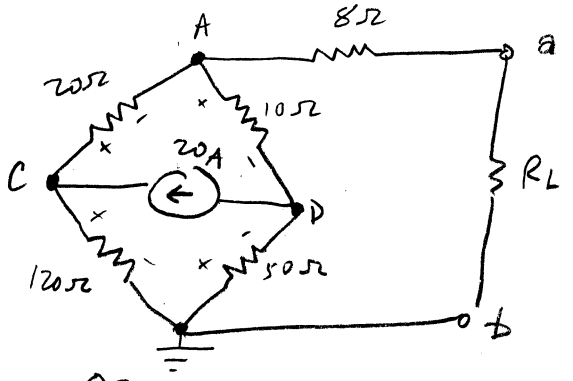
b)

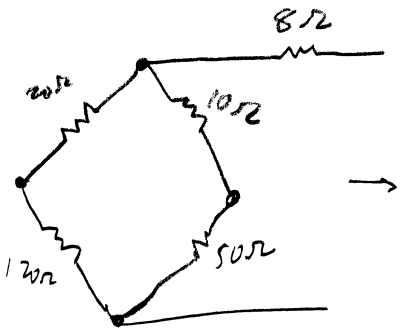
$v = \left(\frac{40}{40+40}\right)8 = 4V$

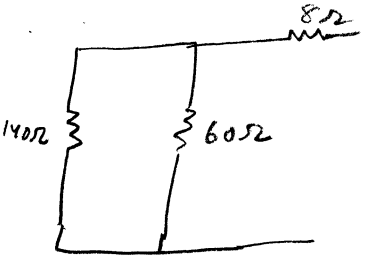
$4V = \left(\frac{R_L}{20+R_L}\right)4V \quad R_L \Rightarrow \infty$

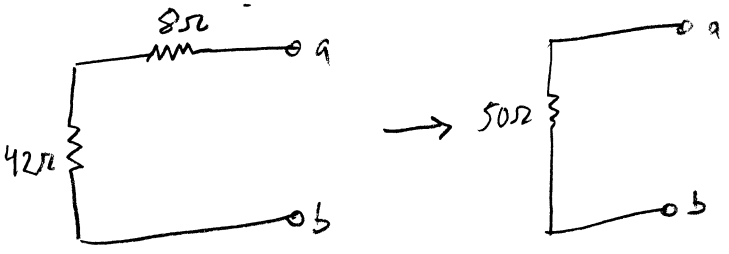
c) $i_{max} = \frac{4V}{20\Omega} = 0.2A$ $\quad R_L \longrightarrow 0$

2)









$R_T = 50\Omega$

+4

KCL A: $\frac{V_C - V_A}{20\Omega} - \left(\frac{V_A - V_D}{10\Omega}\right) = 0$ $\quad \frac{V_C}{20\Omega} - V_A\left(\frac{1}{20} + \frac{1}{10}\right) + \frac{V_D}{10\Omega}$

KCL C: $-\frac{V_C}{120} - \left(\frac{V_C - V_A}{20}\right) + 20A = 0$ $\quad = \frac{-V_C}{120} - \frac{V_A}{20} + \frac{V_C}{20} = V_C\left(\frac{1}{20} - \frac{1}{120}\right) - \frac{V_A}{20}$

KCL D: $\left(\frac{V_A - V_D}{10}\right) + \frac{-V_D}{50} - 20A = 0$ $\quad \frac{V_A}{10} + V_D\left(\frac{1}{50} - \frac{1}{10}\right) = 20$

A $\quad \frac{V_C}{20\Omega} + \frac{V_D}{10\Omega} = V_A\left(\frac{3}{20}R\right)$ $\quad$ C: $V_C\left(\frac{1}{24}\right) - V_A\left(\frac{1}{20}\right) = -20$

D: $\frac{V_A}{10} - V_D\left(\frac{2}{25}\right) = 20$

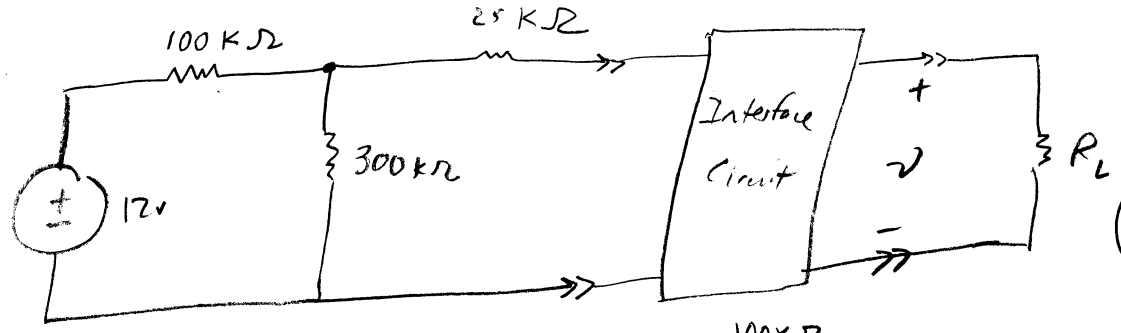
$V_A = 14.00 \quad V_C = 1300 \quad V_D = 1500$

$V_R = 1400\,V$ $\quad V = IR$ $\quad \frac{V}{R} = \frac{14}{50} = 0.28\,A$

$P = Vi = 14 \times 0.28 = 3.92\,W$

OK given error

3)



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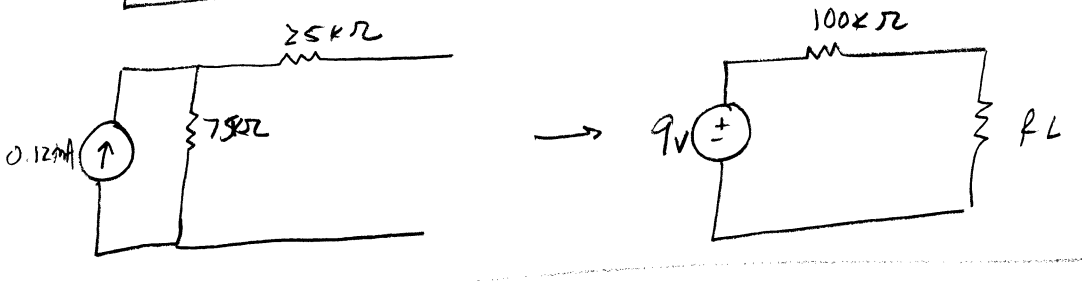


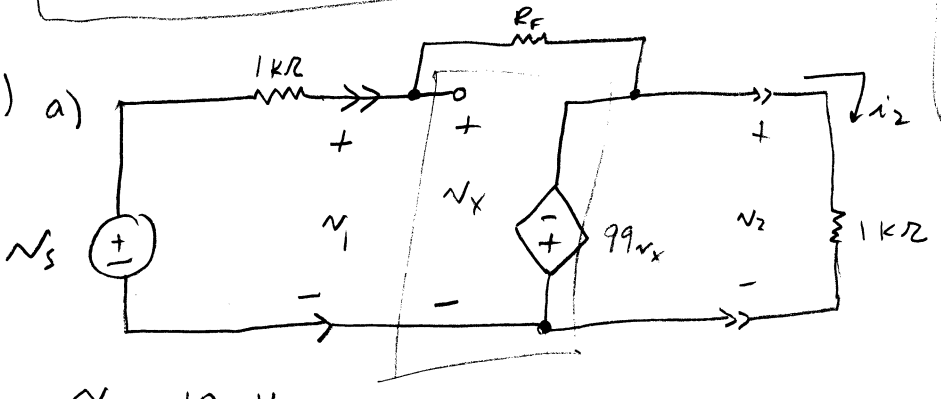
$R_T = 100K\Omega$

$V_T = 9V$

$$P_{max} = \frac{(9)^2}{4(100000)} = 0.2025\,mW$$

This does not exceed 1mW, therefore the interface circuit could be anything.

4) a)



+5

$v_s = 10mV$

$R_F = 10K\Omega$

$$\frac{v_s - v_x}{1k} = \frac{v_x - v_2}{R_F}$$

$99v_x + v_2 = 0$

$v_x = -\frac{v_2}{99}$

$$i_2 = \frac{v_2}{1K\Omega}$$

$$= \frac{-9\times10^{-2}V}{1K\Omega} = -9\times10^{-5}$$

$$v_s - v_x = 1K\left(\frac{v_x - v_2}{R_F}\right)$$

$$v_x = v_s - \left(1K\left(\frac{v_x - v_2}{R_F}\right)\right)$$

$$v_x = v_s - \left(\frac{1000v_x - 1000v_2}{10K\Omega}\right)$$

$$i_1 = \frac{v_s - v_x}{1000}$$

$$= \frac{10mV - 9.09\times10^{-4}V}{1000}$$

$$= 9.091\times10^{-6}$$

$$v_x = \frac{10K\Omega \cdot v_s}{10K\Omega + 1\times10^5} = \frac{10K\Omega \cdot 10mV}{10K\Omega + 1\times10^5} = 9.09\times10^{-4}V$$

$$v_2 = -9\times10^{-2}V$$

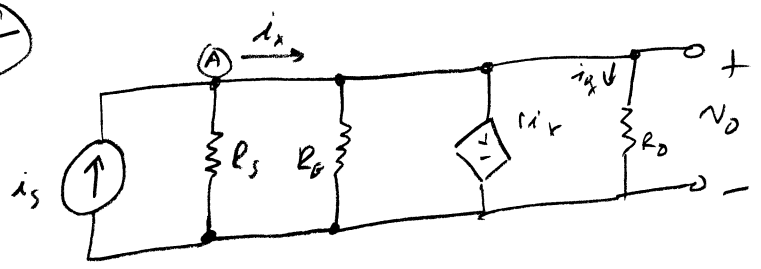
$$\frac{i_2}{i_1} = -9.8999$$

(4) b) $R_{IN} = \frac{v_1}{i_1}$ $\quad v_1 = v_x = 9.09 \times 10^{-4}\ V$

$i_1 = 9.091 \times 10^{-6}\ A$

$$R_{IN} = 99.98\ \Omega$$

(5)



(A) $i_s - i_x - \frac{v_o}{R_s} = 0$ $\quad v_o = r i_x = R_o i_o$

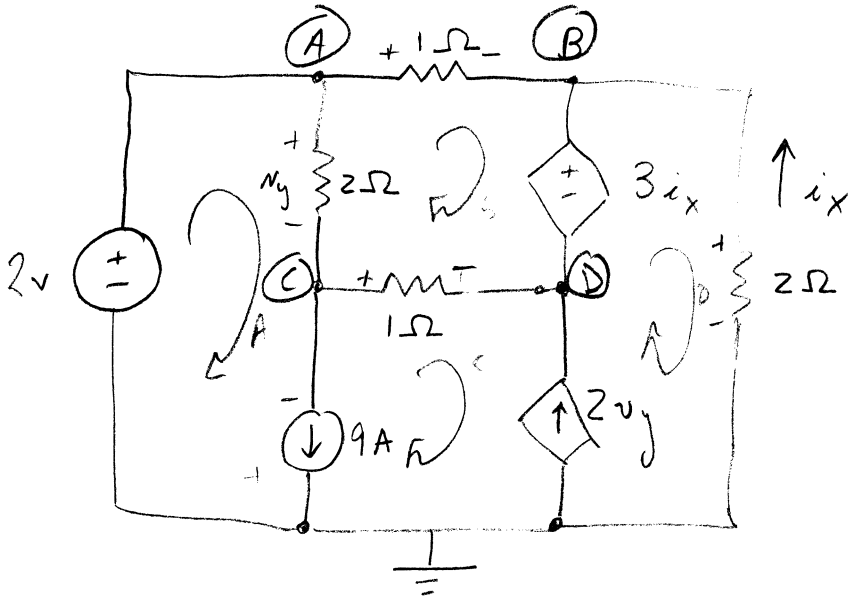
$i_x = \frac{R_o i_o}{r}$

$i_s = i_x + \frac{v_o}{R_s}$

$i_s = \frac{R_o i_o}{r} + \frac{v_o}{R_s}$ $\quad i_o = \frac{\left(i_s - \frac{v_o}{R_s}\right) r}{R_o i_o} = \frac{r i_s - \frac{r v_o}{R_s}}{R_o i_o}$

$$\frac{i_o}{i_s} = \frac{r R_s}{r R_o + R_s R_o}$$

(x5)



+2

$V_A = 2V$ set by source

KCL

(A) $-\left(\frac{V_A - V_C}{2\Omega}\right) - \left(\frac{V_A - V_B}{1\Omega}\right) = 0$ $\quad -\frac{V_A}{2} - \frac{V_C}{2} - V_A + V_B = 0$

(B) $\left(\frac{V_A - V_B}{1\Omega}\right) + i_x = 0$ $\quad V_A - V_B + i_x = 0$ ✓

(C) $\left(\frac{V_A - V_C}{2\Omega}\right) + \left(\frac{V_C - V_D}{1\Omega}\right) = 9$ $\quad \frac{V_A}{2} - \frac{V_C}{2} + V_C - V_D = 9$

(D) $2v_y - \left(\frac{V_C - V_D}{1\Omega}\right) = 0$ $\quad 2v_y - V_C + V_D = 0$

$-V_A\left(\frac{3}{2}\right) - V_C\left(\frac{1}{2}\right) + V_B = 0$ $\quad 2v_y = 2(V_A - V_C)$

$V_A\left(\frac{1}{2}\right) + V_C\left(\frac{1}{2}\right) - V_D = 9$ $\quad i_x = \frac{V_B}{2}$

$2V_A - 2V_C - V_C + V_D = 0$

$2V_A - 3V_C + V_D = 0$

$V_A - V_B + \frac{V_B}{2} = V_A - \frac{V_B}{2} = 0$

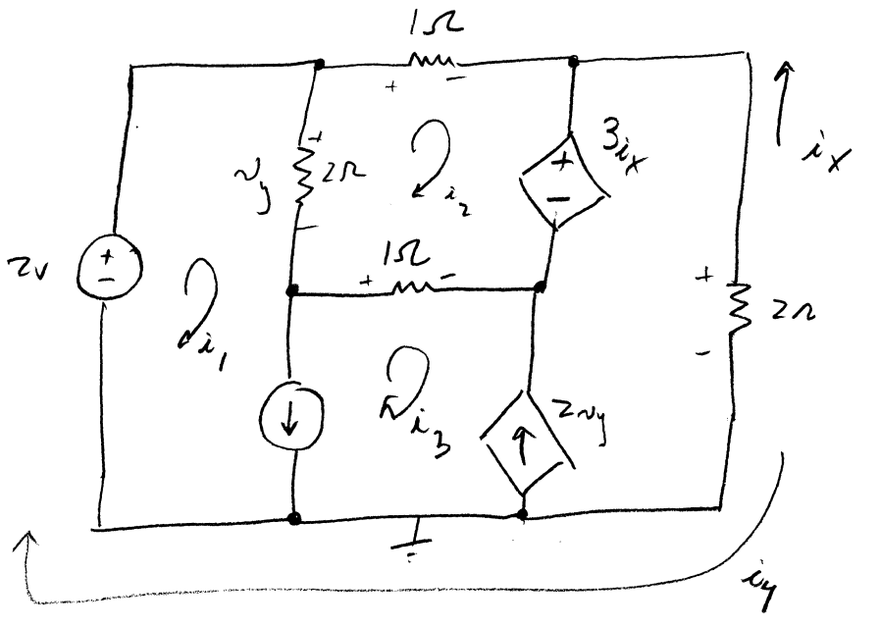
$V_A = -3V$

$V_B = -6V$ ✓

$V_C = -3V$

$V_D = -12V$

→



i_1 $-2v + (i_1 - i_2) = 0$ $\quad 2 = i_1 - i_2$

voltage current?

i_2 $\dfrac{-(i_1 - i_2)}{2} + (i_2 + i_4) - (i_3 - i_2) + 3i_x$

i_3 $(i_3 - i_2) = 0 \quad i_3 = i_2$

i_4 $-2v + (i_2 + i_4) + \dfrac{i_4}{2} = 0$

$2 = i_2 + \frac{3}{2} i_4$

$\dfrac{-i_1}{2} + i_2\left(\dfrac{5}{2}\right) + i_4 - i_3 + 3i_x \qquad i_x = i_2$

$\dfrac{-i_1}{2} + \dfrac{7}{2} i_2 + i_4 - i_3 = 0$

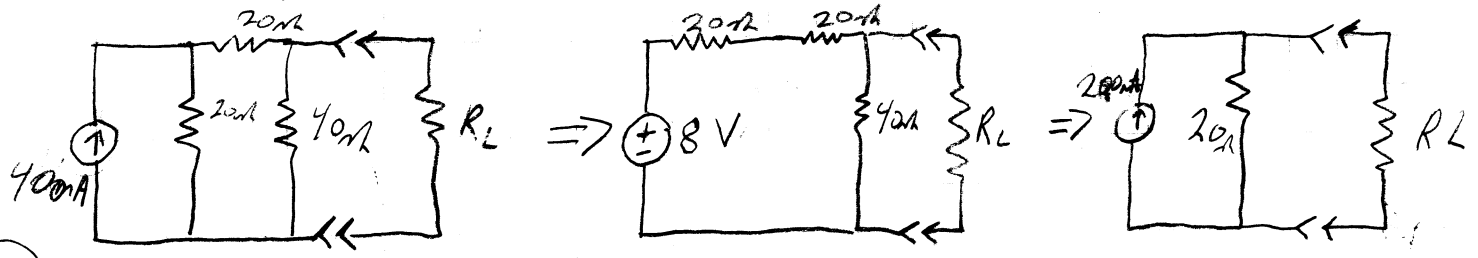
$i_1 = 1.75 \quad i_2 = -0.25 \quad i_3 = -0.25 \quad i_4 = 1.5$

Matthew Gross
Homework #6

21/30

mjg27 ENGR 270 WE

1)



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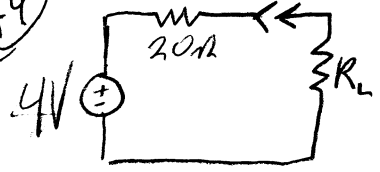


(a) $R_L = R_T = 20\Omega$

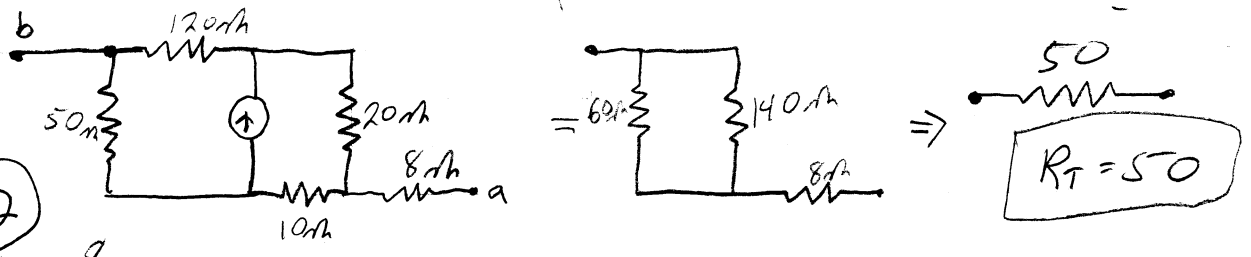
$$P = \frac{V^2}{4R_T} = \frac{(4\ 2)}{4(20)} = \boxed{0.2\ W}$$

(b) $V_{max} = V_T = V_{oc} = \boxed{4\ V}$ $R_L = \infty$

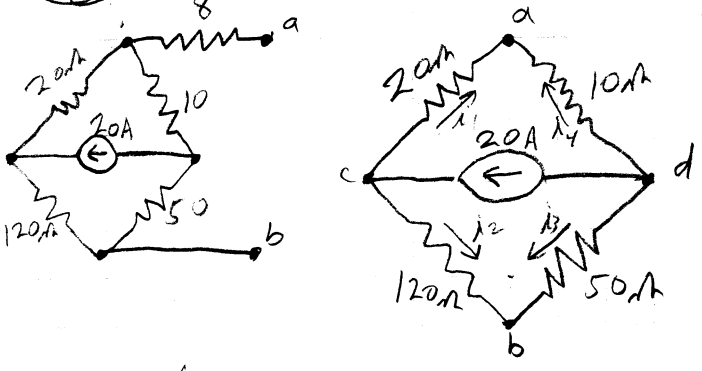
(c) $I_{max} = \frac{V_T}{R_T} = \boxed{0.2A}$ $R_L = 0$

— What is R_L in these cases?

2)



+2



KCL:

A: $G_1(V_C - V_A) - G_4(V_A - V_D) = 0$

C: $-G_2(V_C) - G_1(V_A - V_C) + 20 = 0$

D: $-G_4(V_A - V_D) + G_3 V_C - 20 = 0$

↑ must have opposite signs

?

— 1

$i_1 = G_1(V_A - V_C)$ $i_2 = G_2(V_A - V_D)$ $i_3 = G_3 V_C$ $i_4 = G_4 V_D$ $i_5 = i_{s1}$

A: $(G_1 + G_2)V_A - G_1 V_C - G_2 V_D = 0$

C: $-G_1 V_A + (G_1 + G_3)V_C = 20$

D: $-G_2 V_A + (G_2 + G_4)V_D = -20$

$-G_1 V_A + (G_1 + G_3)V_C = G_2 V_A - (G_2 + G_4)V_D$

$-G_1 V_A + (G_1 + G_3)V_C = G_2 V_A - (G_2 + G_4)V_D$

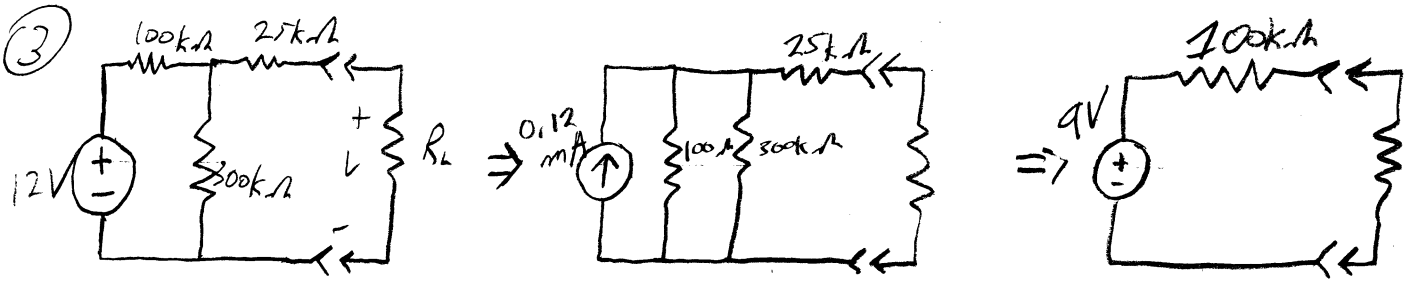
$G_1 V_A + G_2 V_A = (G_1 + G_3)V_C + (G_2 + G_4)V_D$

$$V_A = \frac{(G_1 + G_3)V_C + (G_2 + G_4)V_D}{(G_1 + G_2)}$$

$R_T = ?$ $P_{max} = ?$

— 2

(3)



(x5) $P_{max} = \frac{V^2}{4R} = \frac{9^2}{4(100\times10^3)} = \boxed{2.025\times10^{-4}\ W}$

Since this value is less than 1mW you do not need any resistors you can just use 2 wire.

(9) $i_1 = i_F \quad \therefore \quad V_x = -V_2/99$

$i_1 = \frac{V_s - V_x}{1K} = \frac{V_x - V_2}{R_F}$ (x5)

$10 + V_2/99 = \frac{-V_2/99 - V_2}{10} \Rightarrow 10mV + V_2/99 = \frac{(-V_2/99)}{10} - V_2/99$

$\Rightarrow 10mV + V_2/99 = -V_2/990 - V_2/10 \Rightarrow 10mV = \frac{-10V_2}{990} - V_2/990 - \frac{99V_2}{990}$

$10mV = -100V_2/990 \quad \therefore V_2 = \frac{-10mV(990)}{110} = \boxed{-0.09V = V_2}$

$i_2 = \frac{V_2}{1k\Omega} \quad \frac{-0.09}{1k\Omega} = -9\times10^{-5}$

$V_x = V_2/0.09 = 9.09\times10^{-4}$

$\boxed{\frac{i_2}{i_1} = \frac{-9\times10^{-5}}{9.091\times10^{-6}} = -9.8999}$

$i_1 = \frac{V_s - V_x}{1k} = \frac{10mV - 9.09\times10^{-4}}{1K\Omega} = 9.091\times10^{-6}$

$R_{in} = \frac{V_1}{i_1} \quad i_1 = 9.0991\times10^{-6}$
$V_1 = V_x = 9.09\times10^{-4}$

$\boxed{\frac{9.09\times10^{-4}}{9.091\times10^{-6}} \approx 100\Omega = R_{in}}$

#2

$$G_1V_C + G_2V_D = = (G_1+G_3)V_C + (G_2+G_4)V_D$$

$$-G_3V_C = (G_2+G_4)V_D - G_2V_D$$

$$V_C = -\frac{(G_2+G_4)V_D - G_2V_D}{G_3}$$

$$(G_1+G_2)\left(\frac{(G_1+G_3)V_C + (G_2+G_4)V_D}{(G_1+G_2)}\right) - G_1\left(\frac{(G_2+G_4)V_D - G_2V_D}{G_3}\right) - G_2V_D = 0$$

$$(G_1+G_3)\left(\frac{-(G_2+G_4)V_D - G_2V_D}{G_3}\right) + (G_2+G_4)V_D - G_1\left(\frac{(G_2+G_4)V_D - G_2V_D}{G_3}\right) - G_2V_D = 0$$

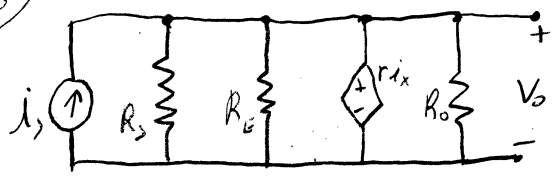
$$(G_2+G_4)V_D = (G_1+G_3)\left(\frac{(G_2+G_4)V_D - G_2V_D}{G_3}\right) + G_1\left(\frac{(G_2+G_4)V_D - G_2V_D}{G_3}\right) + G_2V_D$$

$$V_D = -0.2$$

$$V_C = 1/6$$

$$V_A = 1.03$$

(5)



$i_s = i_{R_s} + i_x \qquad i_{R_s} = V_o / R_s$

$i_s = V_o / R_s + i_x \qquad V_o = i R_o$

$ri_x = V_o \qquad i_x = i_o R_o / r$

$$\frac{i_o}{i_s} = \frac{(V_o/R_o)}{(V_o/R_s) + (V_o/r)}$$

(+4)

Answer should only have R's

−4

(6) a) $i_1 - i_2 = 9$ $\quad i_4 - i_2 = 2V_y$ $\quad -2 + i_3(7) + i_4(2) = 0$

$$(i_3 - i_1)(2) + (1)(i_3) + 3i_x + (1)(i_3 - i_2) = 0$$

$$-2i_2 - 2i_1 + i_3 + 3i_x + i_3 - i_2 = 0$$

$$3i_x = 2i_1 + i_2$$

$$3i_x = 2i_2 + 18 + i_2 = 3i_2 + 18$$

+1

What are i_1, i_2 etc. I need a picture.

−1

1

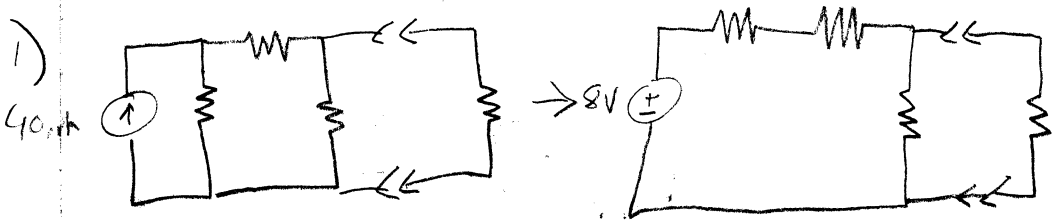
Node Voltage −2

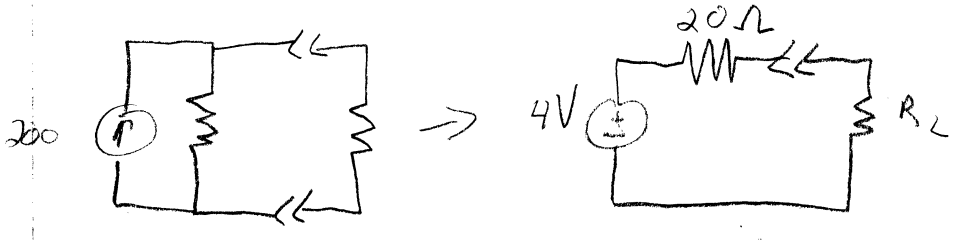
Answers −1

Sean Hayward
WE

21/30

1)





+4

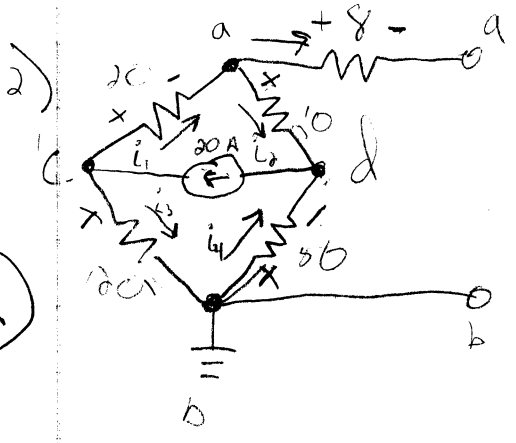
a) $R_L = R_T = 20\,\Omega$ $\quad P = \frac{V^2}{R} \rightarrow \frac{4^2}{4(20)} = 0.2\,W$

b) $V_{max} = V_T = V_{OC} = 4\,V$ $\quad R_L = \infty$

c) $i_{max} = \frac{V_T}{R_T} = \frac{4}{20} = 0.2\,A$ $\quad R_L = 0$

−1 What are R_L in these instances?

2)



+2

$8 + (20+120)//(10+50) =$
$50\,\Omega = R_T$

a → $i_1 - i_2 = 0$ → $i_1 = i_2$

c → $20A - i_3 - i_1 = 0$ → $20 = i_1 + i_3$

b → $i_3 - i_4 = 0$ $\quad i_3 = i_4$

d → $-20A + i_4 + i_2 = 0$ $\quad 20 = i_4 + i_2$

−1

$i_1 = i_2 \rightarrow$

$i_1 + i_3 = 20 \rightarrow$

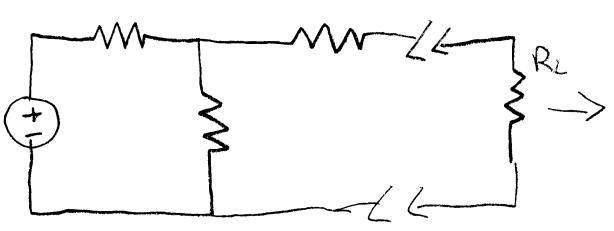
$i_3 = i_4 \rightarrow$

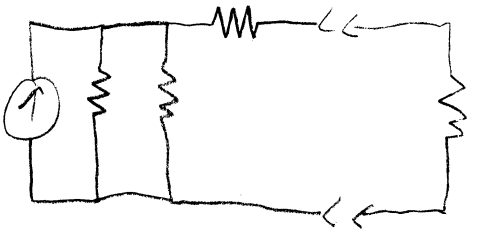
$i_2 + i_4 = 20 \rightarrow$

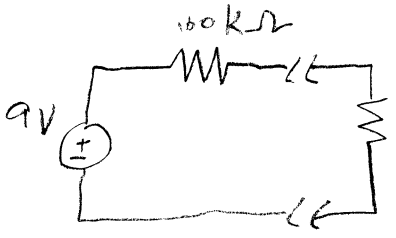
$P_{max} = ?$ -2

#5

3)







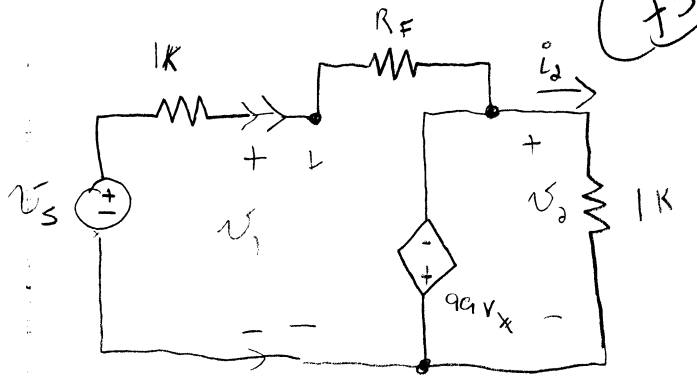
Try with just wires first →

$$P_{max} = \frac{V^2}{4R} = \frac{9^2}{4(100\times10^3)} = 2.025\times10^{-4}\,W$$

The power from the source is less than 1mW, so you don't need any type of additional resistors

15

4)



$v_s = 10\,mV$

$R_F = 10K\Omega$

Find v_2 + i_2/i_1

$R_{in} = V_1/i_1$

$i_1 = i_x \rightarrow \frac{V_s - V_x}{1K} = \frac{V_x - V_2}{R_F} \rightarrow 99V_x + V_2$

$V_x = -\frac{V_2}{99}$

$$\frac{10mV + \frac{V_2}{99}}{} = \frac{-\frac{V_2}{99} - V_2}{10}$$

$$10mV + \frac{V_2}{99} = \frac{\left(-\frac{V_2}{99}\right) - \frac{V_2}{10}}{10} \rightarrow 10mV + \frac{V_2}{99} = -\frac{V_2}{990} - \frac{V_2}{10}$$

$$10mV = -\frac{V_2}{99} - \frac{V_2}{990} - \frac{V_2}{10}$$

$$10mV = \frac{-10V_2}{990} - \frac{V_2}{990} - \frac{99V_2}{990}$$

$$10mV = \frac{-110V_2}{990}$$

$$V_2 = \frac{-10mV(990)}{110} = -0.09\,V$$

$$i_2 = \frac{v_2}{1K\Omega} \qquad \frac{-0.09}{1K\Omega} = -9\times10^{-5}$$

$$\frac{i_2}{i_1} = \frac{-9\times10^{-5}}{9.091\times10^{-6}} = -9.8999$$

$$V_x = \frac{-V_2}{-0.09} = 9.09\times10^{-4}$$

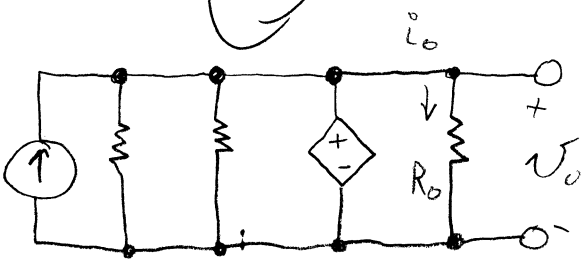
$$i_1 = \frac{v_s - v_x}{1K} = \frac{10mV - 9.09\times10^{-4}}{1K} = 9.091\times10^{-6}$$

$$R_{in} = \frac{V_1}{i_1} \qquad V_1 = V_x = 9.09\times10^{-4}$$

$$i_1 = 9.091\times10^{-6}$$

$$\frac{9.09\times10^{-4}}{9.091\times10^{-6}} \simeq 100\Omega$$

5)



i_o/i_s

$i_s = i_1 + i_x$ $\quad i_s = \frac{V_o}{R_s} + i_x$ $\quad V_o = i_o R_o$ $\quad i_o = V_o/R_o$

$i_1 = \frac{V_o}{R_s}$

$V_o = r i_x$ $\quad r i_x = i_o R_o$

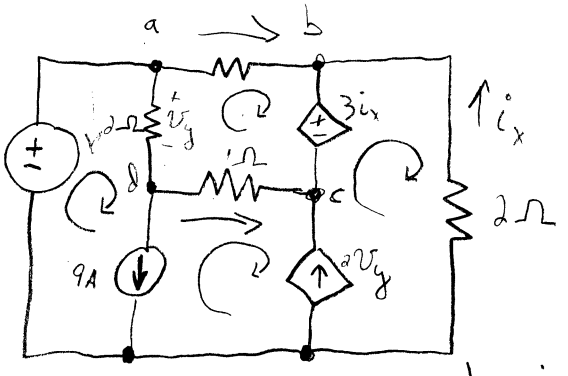
$i_x = \frac{i_o R_o}{r}$

$\frac{i_o}{i_s} = \frac{(V_o/R_o)}{\left(\frac{V_o}{R_s}\right) + \left(\frac{V_o}{r}\right)}$ $\quad -4$

$V_o = r i_x$

Answer should only have R's

6)



What is i_1, i_2 etc.?

$i_1 - i_2 = 9$

$i_4 - i_2 = 2v_g$ $\quad -1$

$-i_3 + 2i_4 = 2$

$2i_1 - 2i_3 - 3i_4 + i_2$

Node Voltage -2

Answers -1