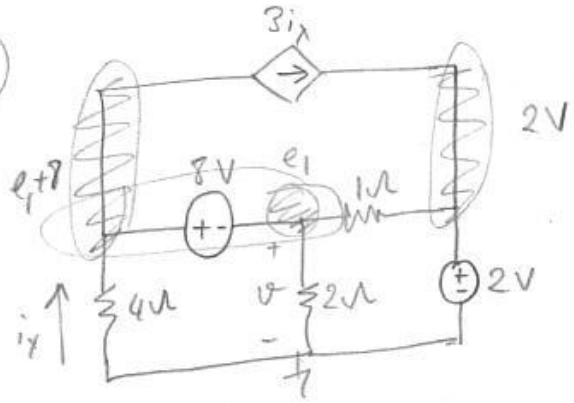
18.10.2004
G.C.

EE 209
Midterm #1
Solutions

1)



a) KCL at Supernode : $\frac{e_1+8}{4} + 3i_x + \frac{e_1-2}{1} + \frac{e_1}{2} = 0$

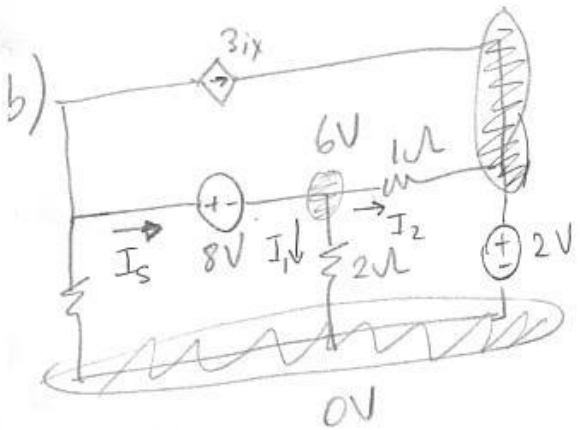
$i_x = \frac{0-(e_1+8)}{4}$

$e_1\left(\frac{1}{4} - \frac{3}{4} + 1 + \frac{1}{2}\right) = -2 + 6 + 2$

$e_1 = 6\ V$ *

$v = e_1 = 6V$

b)



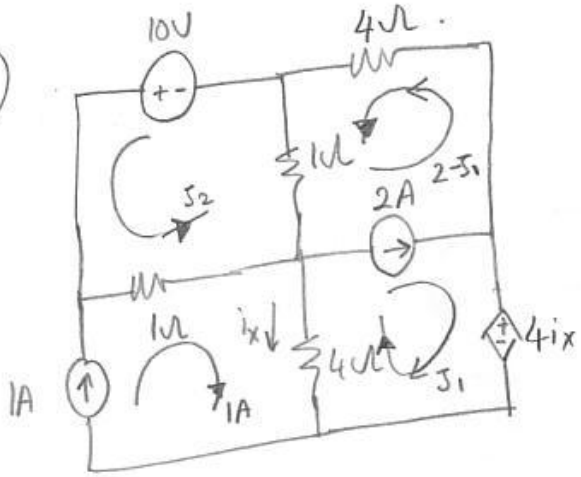
$I_s = I_1 + I_2$

$= \frac{6-0}{2} + \frac{6-2}{1} = 7A.$

$P = 8 \cdot I_s = 56$ Watts.

Absorbed.

(2)



$J_2 = i_s$

Mesh J_2: $-10 + 1(J_2+1) + 1(J_2+J_1-2) = 0$ (1)

Mesh J_1 union Mesh $(2-J_1)$: (Supermesh)

$4(2-J_1) + 1(2-J_1-J_2) + 4(1-J_1) - 4i_x = 0$ (2)

$i_x = (1-J_1)$

(1): $J_1 + 2J_2 = 11$

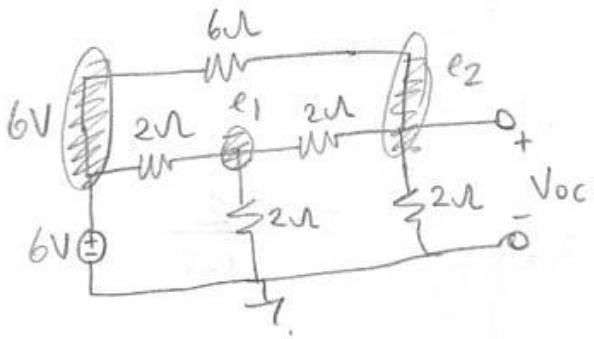
(2): $-5J_1 - J_2 = -10$

$$J_2 = \frac{55-10}{10-1} = \frac{45}{9} = 5A.$$

$I_s = 5A$ //

Problem 3:

a) V_{oc}:



$e_2 = V_{oc}$,

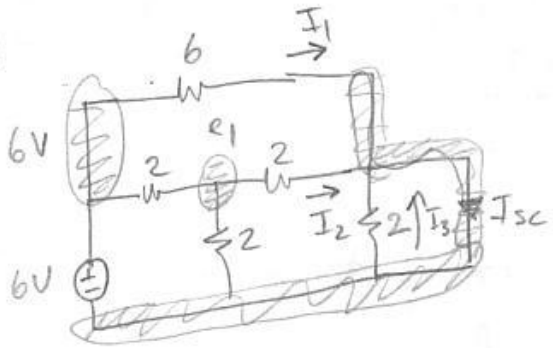
KCL at e_1: $\frac{e_1-6}{2} + \frac{e_1}{2} + \frac{e_1-e_2}{2} = 0 \rightarrow 3e_1 - e_2 = 6$

KCL at e_2: $\frac{e_2}{2} + \frac{e_2-e_1}{2} + \frac{e_2-6}{6} = 0 \rightarrow -3e_1 + 7e_2 = 6$

$6e_2 = 12$

$V_{oc} = e_2 = 2V$.

I_{sc}:



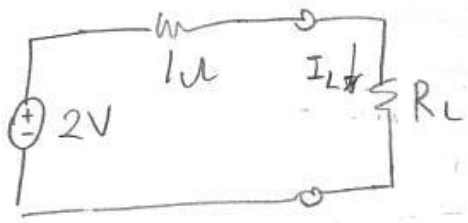
KCL at e_1: $\frac{e_1-6}{2} + \frac{e_1}{2} + \frac{e_1}{2} = 0 \rightarrow e_1 = 2V$

$I_{sc} = I_1 + I_2 + I_3 = \frac{6-0}{6} + \frac{e_1-0}{2} + \frac{0-0}{2} = 1 + \frac{e_1}{2} = 2A.$

$$R_{Th} = \frac{V_{oc}}{I_{sc}} = \frac{2}{2} = 1\Omega$$

a) $R_L = R_{Th} = 1\Omega$ for maximum power transfer

b)



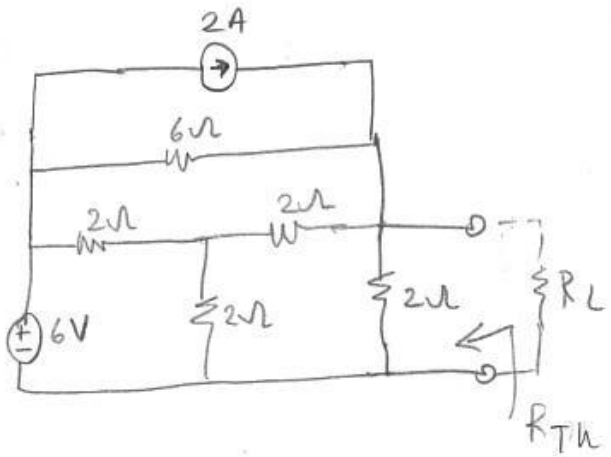
$$I_L = \frac{2}{1+R_L}$$

I_L for max. power transfer $\Rightarrow \hat{I}_L = \frac{2}{2} = 1A$

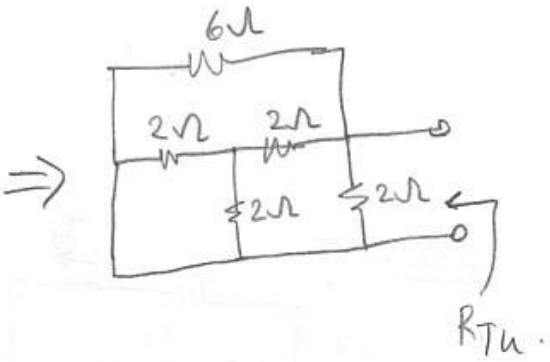
Maximum Power $\Rightarrow P_{max} = \left(\hat{I}_L\right)^2 \cdot 1$

$= 1$ Watt.

c)



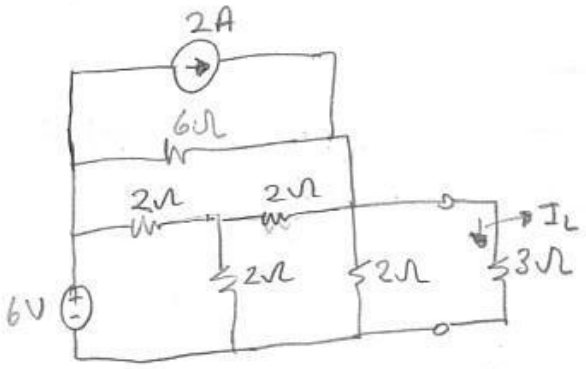
Kill the sources

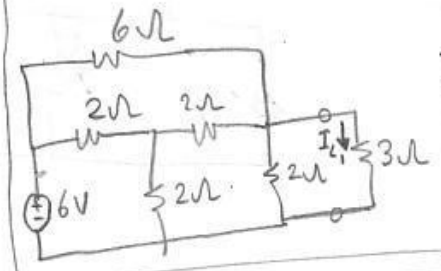


Note that the circuit in part (a) and in part (c) have the same R_{Th}. Therefore for maximum power transfer $R_L = 1\Omega$ as in part (a).

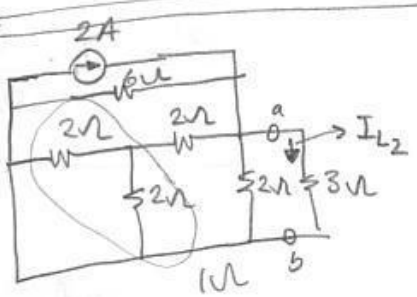
Then by superposition:

(3c) cont.





$I_{L_1} = 3A$ from part (b)



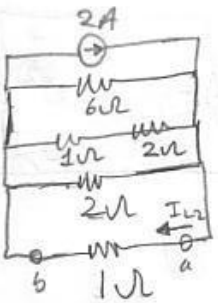
$I_{L_2} = 1A$

$$I_L = I_{L_1} + I_{L_2}$$

$$I_L = 1 + 1$$

$$I_L = 2A$$

$$P_{max} = (I_L)^2 \cdot 1 = 4 \text{ Watt}$$



$$I_{L_2} = 2 \cdot \frac{1/1}{\frac{1}{6} + \frac{1}{3} + \frac{1}{2} + 1}$$

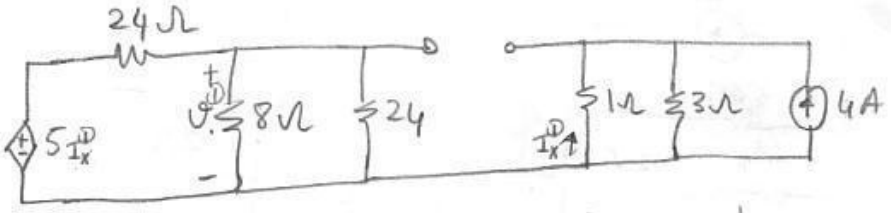
$$= 1A$$

$$I_{L_2} = 1A.$$

Problem 4:

Sources:

4A: ON
(1) 10V: OFF
8A: OFF

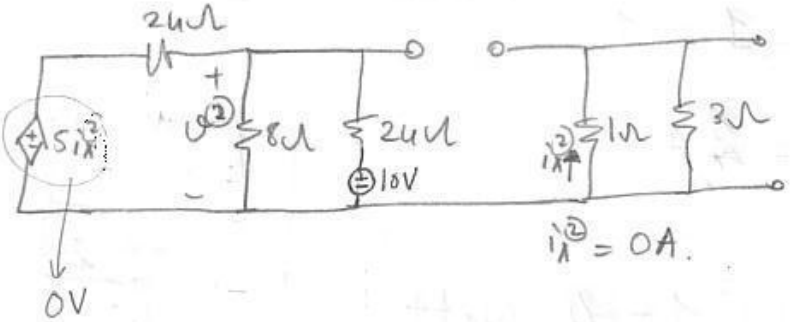


$I_x^{(1)} = -3A$

$v^{(1)} = 5i_x \cdot \frac{8\|24}{8\|24+24} = 5(-3)\frac{6}{6+24} = -3V$

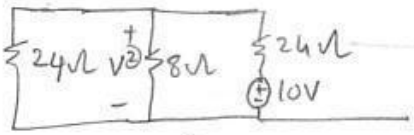
Sources

4A: OFF
(2) 10V: ON
8A: OFF



$i_x^{(2)} = 0A.$

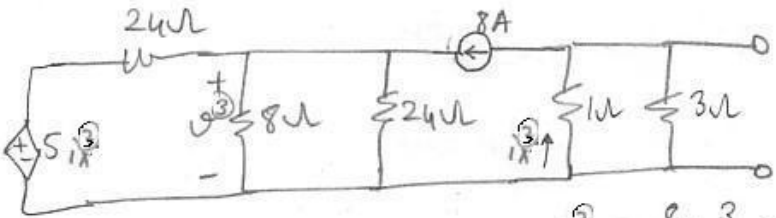
0V



$V^{(2)} = \frac{10}{24+24\|8} \cdot (24\|8) = \frac{10}{24+6} \cdot 6 = 2V$

Sources:

4A: OFF
(3) 10V: OFF
8A: ON



$i_x^{(3)} = 8 \cdot \frac{3}{3+1} = 6A.$

$v^{(3)} = 5i_x^{(3)} \cdot \frac{8\|24}{8\|24+24} + 8 \cdot (24\|8\|24) = 6 + 8 \cdot \frac{24.6}{5} = \frac{222}{5} = 44.4$

$v = v^{(1)} + v^{(2)} + v^{(3)} = -3 + 2 + 44.4 = 43.4\,V$