

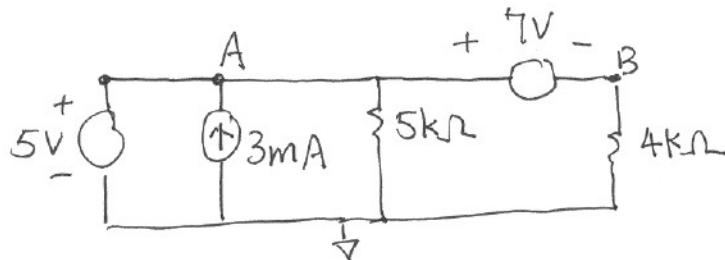
Homework #2 Solutions.

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modified by Jie Zhou

EECS 42
Fall 2003

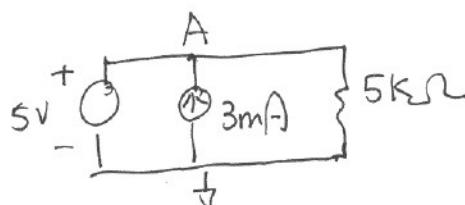
1.1

Fig. 2.31 :



a) KVL, find V_A :

Look at modified ckt:

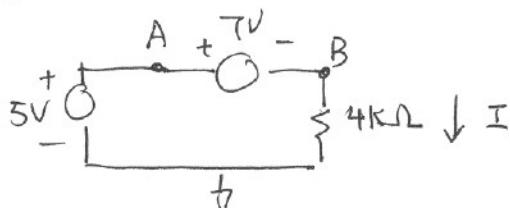


$$-V_A + 5V = 0$$

$$\boxed{V_A = 5V} \quad \times$$

b) KVL around outside loop, find V_B :

Look at modified ckt loop:



$$-V_B + (-7V) + 5V = 0$$

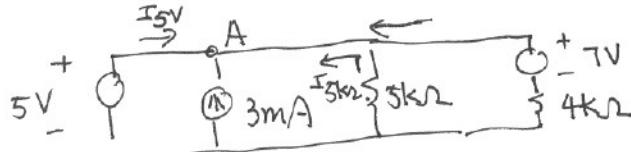
$$-V_B - 2V = 0$$

$$\boxed{V_B = -2V} \quad \times$$

c) Find R_1 :

$$\frac{V_B - 0}{4k\Omega} = I_{4k\Omega} = \frac{-2V}{4k\Omega} = \boxed{-\frac{1}{2}mA} \quad \times$$

d).



$$I_{5k\Omega} = \frac{(V_A - 0)}{5k\Omega} = \frac{-5V}{5k\Omega} = -1mA$$

KCL at node A:

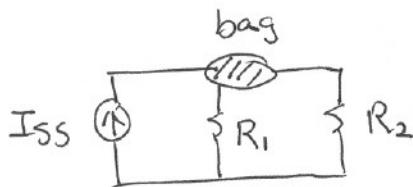
$$I_{5V} + 3mA + (\frac{1}{2}mA) + (-1mA) = 0$$

$$I_{5V} + 2\frac{1}{2}mA = 0$$

$$\boxed{I_{5V} = -2\frac{1}{2}mA} \quad \times$$

11.2

a). modified ckt:



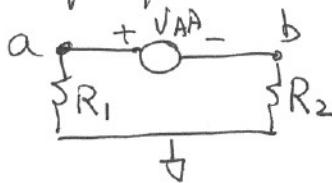
KCL at bag node:

$$I_{ss} = I_{R_1} + I_{R_2}$$

$$2mA = 1mA + I_{R_2}$$

$$\boxed{I_{R_2} = 1mA} \quad \times$$

b) KVL of right window:



KVL:

$$-V_B + (-V_{AA}) + V_a = 0$$

$$-2V + (-1V) = -V_a$$

$$\boxed{V_a = 3V} \quad \times$$

$$V_B = R_2 \cdot I_{R_2} = 2k\Omega \cdot 1mA = 2V.$$

c). $R_1 = ?$

$$V_a = 3V, V_a = R_1 \cdot I_{R_1} = R_1 \cdot 1mA$$

$$\boxed{R_1 = \frac{3V}{1mA} = 3k\Omega} \quad \times$$

d). Left KVL loop: $-V_A + V_A = 0$

$$-V_A + V_{SS} = 0$$

$$V_A = V_{SS} \sim (1)$$

Right KVL loop: $V_B + (-V_{AA}) + V_A = 0 \sim (2)$

$$\text{Add (1) + (2): } -V_B + -V_{AA} + V_{SS} = 0$$

$$V_{SS} = V_B + V_{AA} \sim (3)$$

KVL of outside loop: $-V_B + (-V_{AA}) + V_{SS} = 0$

$$V_{SS} = V_B + V_{AA} \sim (4).$$

\therefore eqn (3) + (4) are same \times

1.3

a) Time for $V_C \rightarrow 0$ to $2V$:

$$\frac{1}{C} \text{pF} \downarrow 1 \text{nF}$$

$$V_C = \frac{I \cdot t}{C} + K$$

$$2V = \frac{1 \text{nA} \cdot t}{1 \text{pF}} + 0$$

$$\text{time } t = 2E - 9 \text{ sec} = \boxed{2 \text{ nsec.}} \times \text{ for } 0 \rightarrow 2V \text{ case.}$$

time for V_C from 2 to $4V$ is also 2 nsec by similar calculation

$$\boxed{\boxed{t_{2 \rightarrow 4V} = 2 \text{ nsec}}} \times \text{ for } 2V \rightarrow 4V \text{ case.}$$

$$\begin{aligned} b). \quad E_{0 \rightarrow 2V} &= \frac{1}{2} C (V_{\text{final}}^2 - V_{\text{initial}}^2) \\ &= \frac{1}{2} (1 \text{ pF}) (2^2 - 0^2) \\ &= 2 \text{ pJ} \end{aligned}$$

$$\begin{aligned} E_{2 \rightarrow 4V} &= \frac{1}{2} C (4^2 - 2^2) \\ &= \frac{1}{2} (1 \text{ pF}) (12) \\ &= 6 \text{ pJ} \end{aligned}$$

$$6 \text{ pJ} - 2 \text{ pJ} = \boxed{4 \text{ pJ}} \times \text{ added energy in going from } 2 \rightarrow 4V \text{ compared to } 0 \rightarrow 2V.$$

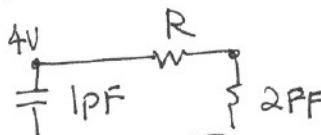
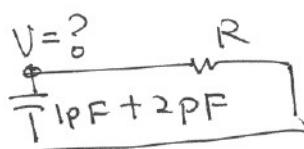
c).

$$Q = CV$$

$$Q = 1 \text{ pF} (4V)$$

$$Q = 4 \text{ pC}$$

for

 \downarrow to

$$Q = CV$$

$$4 \text{ pC} = 3 \text{ pF} V$$

$$\frac{4 \text{ pC}}{3 \text{ pF}} = V$$

$$\boxed{\boxed{V = \frac{4}{3} V}} \times$$

d)

$$E = \frac{1}{2} (C_{tot}) V^2 = \frac{1}{2} (3 \mu F) \left(\frac{4}{3} V \right)^2$$

$$= \frac{1}{2} (3 \mu F) \left(\frac{16}{9} V \right)$$

$$\boxed{E = \frac{8}{3} PJ} \times$$

e).

$$8 \mu J - \frac{8}{3} \mu J = \frac{16}{3} \mu J$$

$$\boxed{E_{lost} = \frac{16}{3} \mu J} \times$$

The lost energy is dissipated thru the Resistor.

11.4

a) $V_{oc} = V_{out} \Big| I_{IN} = 0$

KCL at B: $I_{R1} + I_{IN} + I_{S2} = 0$

$$I_{R1} + 0 + 1mA = 0$$

$$\boxed{I_{R1} = -1mA} \times$$

$$I_{R1} = \frac{V_A - V_B}{R_1}$$

$$V_A - V_B = I_{R1} \cdot R_1 = -1V.$$

$$V_A - V_B = -1V$$

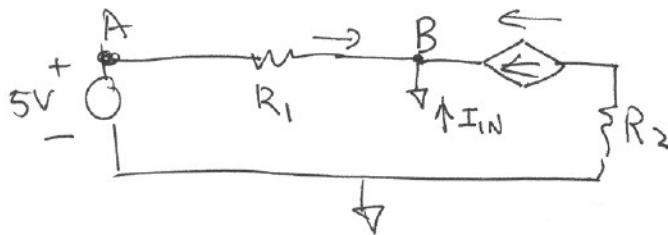
$$5V - V_B = -1V$$

$$V_B = 6V$$

$$V_{oc} = V_B = 6V$$

$$\boxed{V_{oc} = 6V} \times$$

$$b). I_{SC} = I_{IN} \Big|_{V_{out}=0}$$



$$I_{R_1} + I_{IN} + 1mA = 0$$

$$5mA + 1mA = -I_{IN}$$

$$I_{IN} = -6mA$$

$$I_{IN} = I_{SC}$$

$$\boxed{I_{SC} = -6mA} \times$$

$$c). I_{out} \Big|_{V_{out}=1V} = ?$$

$$I_{R_1} = \frac{5V - 1V}{1k\Omega} = \frac{4}{1k\Omega} = 4mA.$$

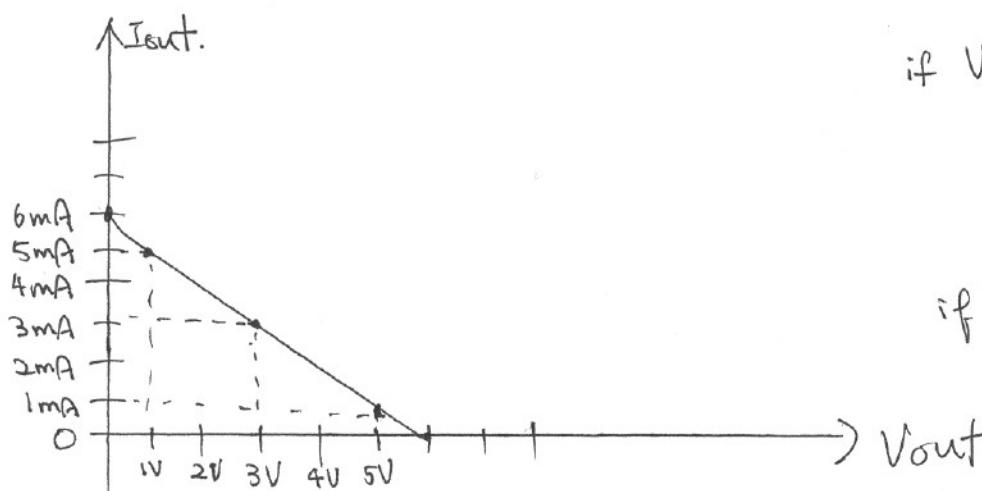
$$I_{R_1} - I_{out} + 1mA = 0$$

$$4mA + 1mA = I_{out}$$

$$\boxed{I_{out} = 5mA} \times$$

Note: the direction of I_{out} is chosen to be opposite of I_{IN} .

d).



$$\text{if } V_B = 3V \rightarrow I_{R_1} - I_{out} + 1mA = 0$$

$$I_{R_1} = \frac{5-3V}{1k\Omega} = 2mA$$

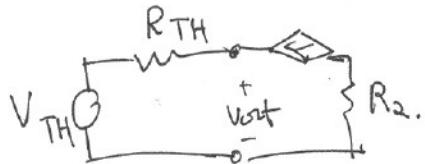
$$\therefore I_{out} = 3mA$$

$$\text{if } V_B = 5V : I_{R_1} = \frac{5V - 5V}{1k\Omega} = 0$$

$$I_{R_1} - I_{out} + 1mA = 0$$

$$I_{out} = 1mA.$$

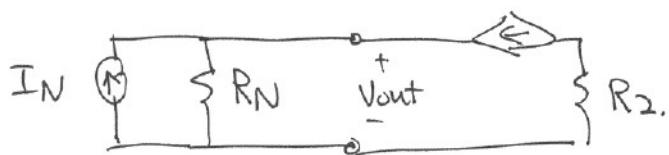
e). Thevenin equivalent ckt:



$$R_{TH} = 1\text{k}\Omega \rightarrow R_{TH} = R_1$$

$$V_{TH} = 5\text{V}$$

f). Norton equi. ckt.



$$I_N = \frac{V_{S1}}{R_1} = \frac{5\text{V}}{1\text{k}\Omega} = 5\text{mA}$$

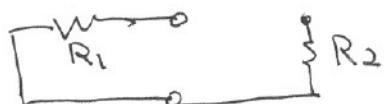
$$R_N = \frac{-V_{OC}}{I_{SC}} = \frac{-6\text{V}}{-6\text{mA}} = 1\text{k}\Omega$$

$$R_N = R_1$$

g). set $V_{S1} = 0 \Rightarrow$ short ckt

set $I_{SC} = 0 \Rightarrow$ open ckt

modified ckt:



the resistance that exists btw the two terminals is the

Thevenin resistance: $\boxed{R_{th} = R_1}$