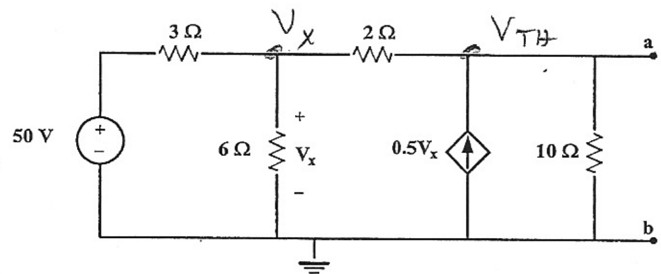
wlg

ECE 301
H.W. #4
FALL 2006

(1) You are given the circuit of Figure 1. Find the Thevenin voltage and Thevenin resistance seen looking into terminals a-b. Ans: $V_{TH} = 166.67$ V, $R_{TH} = 10\ \Omega$



Solution for V_{TH} using Nodal. Node voltages defined above.

At V_x

$$\frac{V_x - 50}{3} + \frac{V_x}{6} + \frac{V_x - V_{TH}}{2} = 0$$

$$2V_x - 100 + V_x + 3V_x - 3V_{TH} = 0$$

$$\boxed{6V_x - 3V_{TH} = 100}$$

At V_{TH}

$$\frac{V_{TH} - V_x}{2} + \frac{V_{TH}}{10} - 0.5V_x = 0$$

$$5V_{TH} - 5V_x + V_{TH} - 5V_x = 0$$

$$\boxed{-10V_x + 6V_{TH} = 0}$$

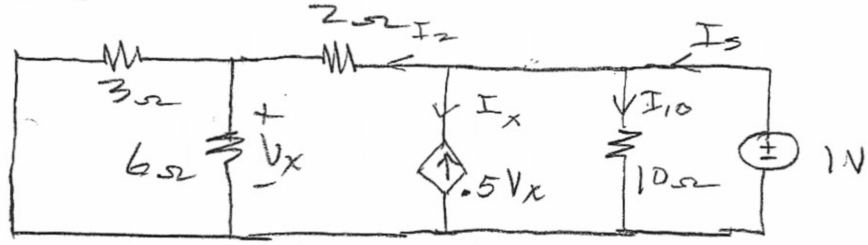
$$\begin{bmatrix} 6 & -3 \\ -10 & 6 \end{bmatrix} \begin{bmatrix} V_x \\ V_{TH} \end{bmatrix} = \begin{bmatrix} 100 \\ 0 \end{bmatrix}$$

$V_{TH} = 166.67$ V

$V_x = 100$ V

(1) cont.

Will work by applying a 1 volt source



$R_{TH} = \frac{1}{I_s}$; FIND I_s

$I_{10} = \frac{1}{10} = 0.1\ A$

$I_s = 0.1 + I_2 - .5V_x$

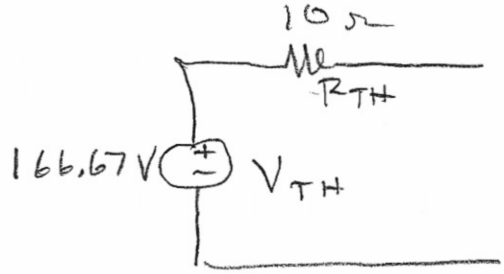
$V_x = \frac{1 \times 2}{2+2} = 0.5\ V$

$I_2 = \frac{1 - V_x}{2} = \frac{0.5}{2} = 0.25$

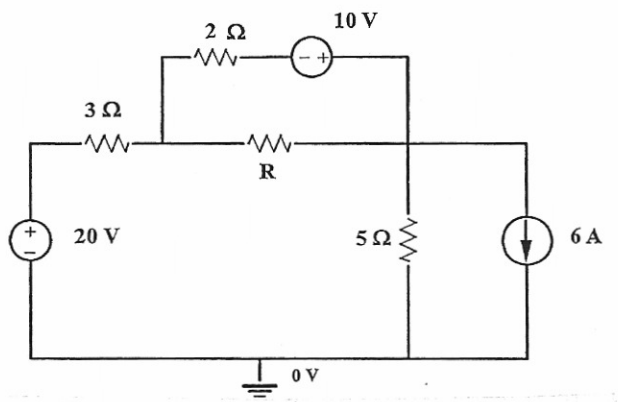
$I_x = -.5V_x = -0.25$

$I_s = 0.1 + 0.25 - 0.25 = 0.1$

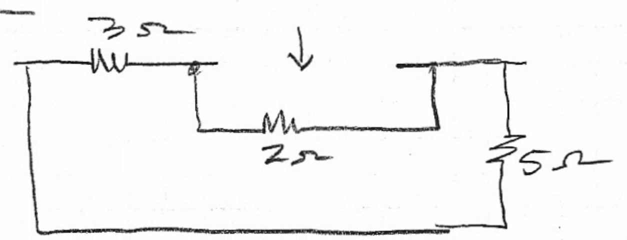
$R_{TH} = \frac{1}{.1} = 10\ \Omega$



(2) You are given the circuit of Figure 2. Find the maximum power that can be deliver to the resistor R. Answer: 625 mW (Along the way, $V_{TH} = 2V$, $R_{TH} = 1.6\ \Omega$)



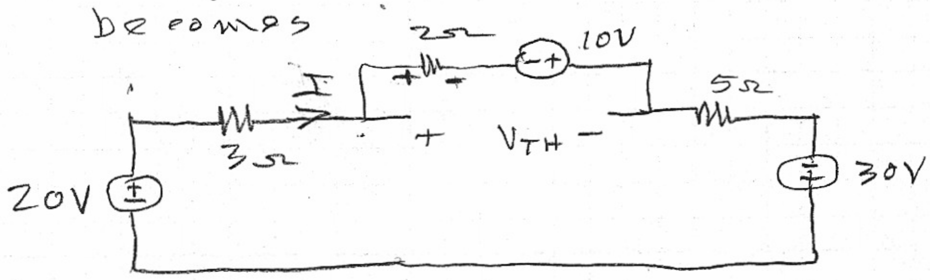
FOR R_{TH}



$R_{TH} = 2 \parallel (3+5) = \frac{2 \times 8}{2+8} = 1.6\ \Omega$

FOR V_{TH}

using a source transformation, ckt becomes



$I = 60/10 = 6\ A$

$V_{TH} - 2 \times 6 + 10 = 0$

$V_{TH} = 2V$

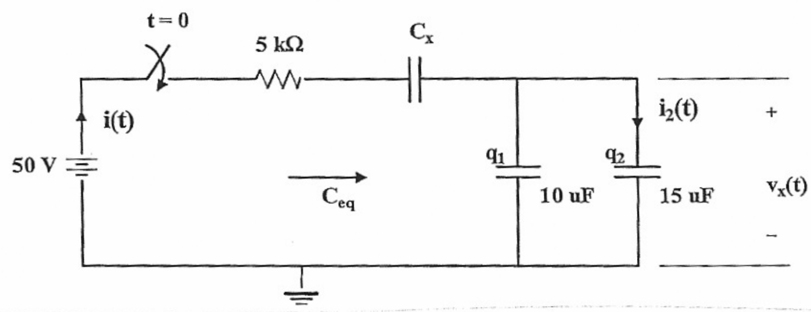
(3) You are given the circuit of Figure 3. It is known that $C_{eq} = 10\,\mu F$.

(a) Determine q_{eq}, q_1, and q_2 in steady state. Ans: $500\,\mu C$, $200\,\mu C$, $300\,\mu C$ 500 uC.

(b) Determine V_x in steady state. Ans: 20 V

(c) Determine $i_2(\infty)$. On your own

(d) Determine $i(0^+)$. Explain your answer. Ans: 10 mA



(a) $C_{eq} = 10\mu F$

$\therefore \quad Q = CV \Rightarrow Q_{eq} = 10\mu F \times 50$

$Q_{eq} = 500\,\mu C$

$V_x = \frac{Q_{eq}}{25\mu F} = \frac{500\,\mu C}{25\mu F} = 20V$

$Q_1 = 10\mu F \times 20V = 200\mu C$

$Q_1 = 200\mu C$

$Q_2 = 15\mu F \times 20V$

$Q_2 = 300\,\mu C$

(b) From the above $V_x = 20\,V$

(c) $t \to \infty$, capacitors look like an open ckt.

$\therefore i_2(\infty) = 0$

(d) initially $(t=0^+)$ capacitors look like shorts

$\therefore i(0^+) = \frac{50}{5k} = 10\,mA$

(4) You are given the circuit of Figure 4.

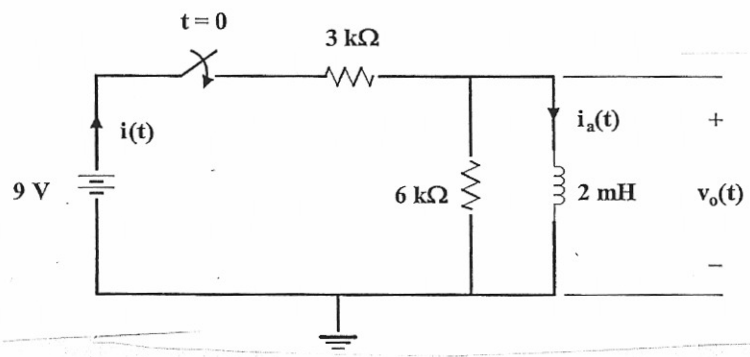
(a) Find $v_o(t)$ for $t = 0^+$. Ans: 6 V

(b) Find $v_o(\infty)$. Ans: On your own

(c) Find $i(0^+)$. 1 mA

(d) Find $i_a(0^+)$ Ans: On your own

(c) Find $i(\infty)$. Ans: On your own



(a) initially coil looks like open ckt,

$\therefore\ V_o(t) = \dfrac{9 \times 6k}{6k + 3k} = 6\ V$

(b) in steady state, coil looks like short circuit.

$\therefore\ V_o(\infty) = 0$

(c) initially coil looks like an open

$\therefore\ i(0^+) = \dfrac{9}{9k} = 1\ mA$

(d) initally coil looks like open

$\therefore\ i_a(0^+) = 0$

(e) with coil as short as $t \to \infty$

$i(\infty) = \dfrac{9}{3k}$

$i(\infty) = 3\ mA$