Faculty of Engineering

ELECTRICAL AND ELECTRONIC ENGINEERING DEPARTMENT

EENG223 Circuit Theory I
INFE221 – Electrical Circuits

Spring 2010-11

Instructors:

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Second Midterm EXAMINATION

May 14, 2011

Duration : 100 minutes

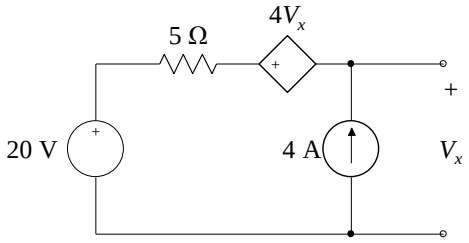
Number of Problems: 4

Good Luck

STUDENT'S	
NUMBER	
NAME	
SURNAME	
GROUP NO	

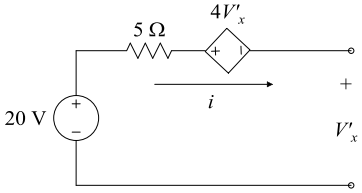
Problem		**Points**
1		25
2		25
3		25
4		25
TOTAL		100

1. Use superposition to find V_x in the following circuit.



Solution

(a) Apply 20 V source only:



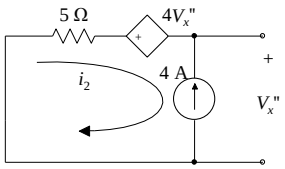
Since $i = 0 \quad 5V_x' = 20 \quad \Rightarrow \quad V_x' = 4 \text{ V}$

Apply 4 A source only:

KVL:

$$5i_2 + 4V_x'' + V_x'' = 0$$

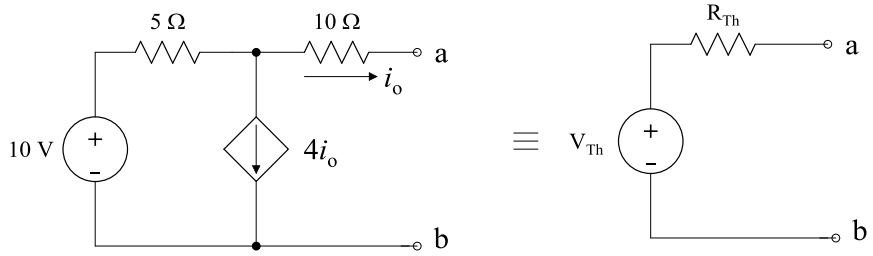
$$i_2 = -4 \text{ A} \quad \Rightarrow \quad V_x'' = 4 \text{ V}$$



$$V_x = V_x' + V_x''$$

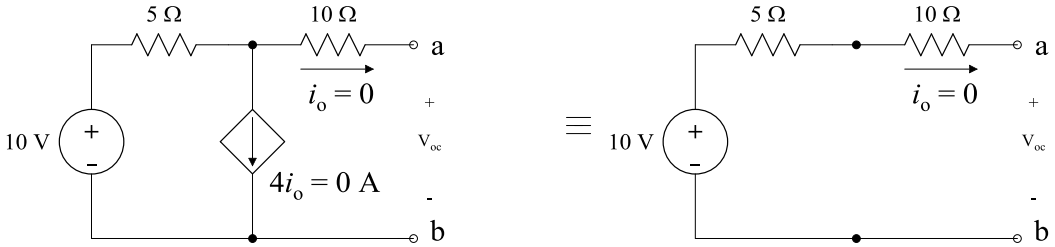
$$V_x = 4 + 4 = 8 \text{ V}$$

2. In the circuit shown, find the Thevenin equivalent with respect to the terminals a-b.



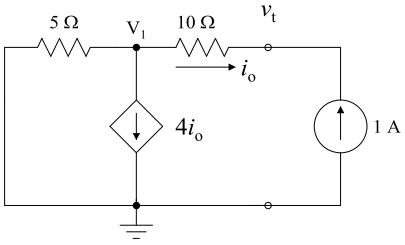
Solution

In order to find $\mathbf{V_{Th}}$



$V_{oc} = 10\text{ V} = V_{Th}$ since $i_o = 0$ A.

R_{Th} : KCL at node V_1:



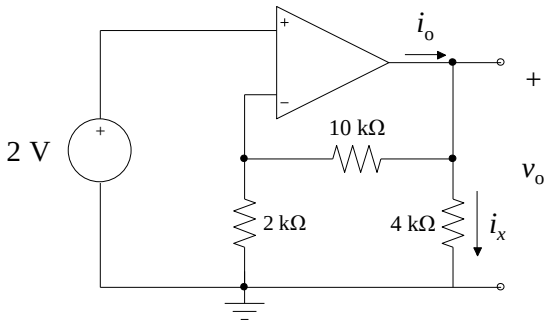
$$\frac{V_1}{5} + 4i_0 + i_0 = 0 \quad \Rightarrow \quad V_1 = -25i_0$$

$$v_t = V_1 - 10i_0 = -35i_0 \quad i_0 = -1\text{ A}$$

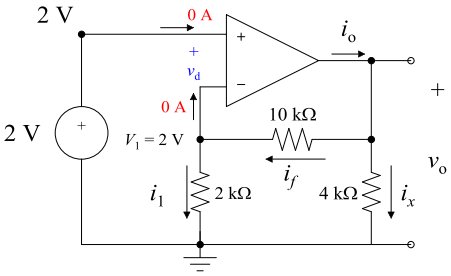
$$\Rightarrow \quad v_t = 35\text{ V}$$

$$\therefore \quad R_{Th} = \frac{v_t}{1\text{ A}} = 35\ \Omega$$

3. In the op-amp circuit shown, find the currents $\boldsymbol{i_o}$ and $\boldsymbol{i_x}$.



Solution



KCL at V_1:

$$i_1 - i_f = 0$$

$$\frac{V_1}{2k} - \frac{V_0 - V_1}{10k} = 0$$

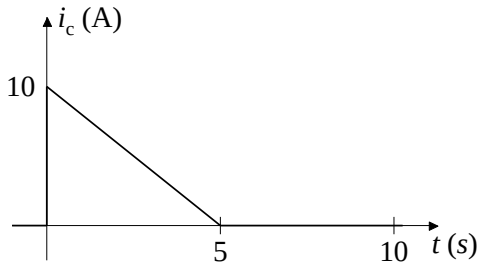
$$6V_1 - V_0 = 0 \Rightarrow V_0 = 6V_1 = 12 \text{ V}$$

$$i_x = \frac{12}{4k} = 3 \text{ mA}$$

$$i_f = \frac{12-2}{10k} = 1 \text{mA}$$

$$i_0 = i_x + i_f = 3 + 1 = 4 \text{ mA}$$

4. The current through a capacitor C = 0.2 F is shown below. The initial capacitor voltage is $v_c(0)$ = 0 V. Find the capacitor voltage for $0 \le \boldsymbol{t} \le 10$ s.



Solution

$$i_c = \begin{cases} 0 & t < 0 \\ 10 - 2t & 0 \le t < 5 \text{ s} \\ 0 & t > 5 \text{ s} \end{cases} \quad \Rightarrow \quad v_c(t) = v_c(0) + \frac{1}{C}\int_0^t i_c(\tau)d\tau = \begin{cases} 0 & t < 0 \\ 5(10t - t^2) & 0 \le t < 5 \text{ s} \\ 125 & 5 \le t \text{ s} \end{cases}$$