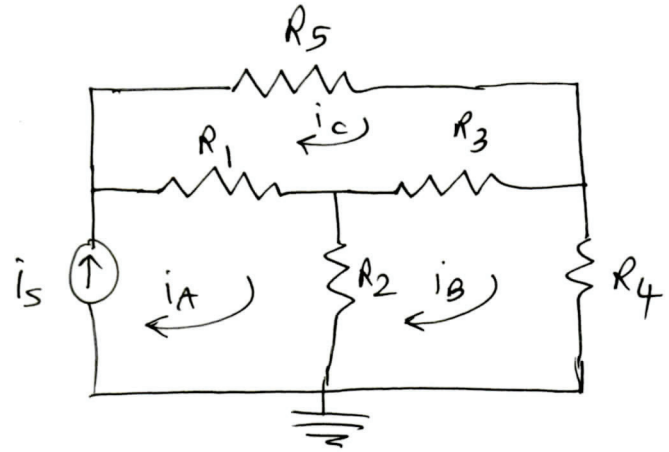
HW#4

MAE 140

Fall 2013

3-1



Using inspection:

$$\underbrace{\begin{bmatrix} 1 & 0 & 0 \\ -R_2 & R_2+R_3+R_4 & -R_3 \\ -R_1 & -R_3 & R_1+R_3+R_5 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} i_s \\ 0 \\ 0 \end{bmatrix}}_{b}$$

$$\Rightarrow Ax = b$$

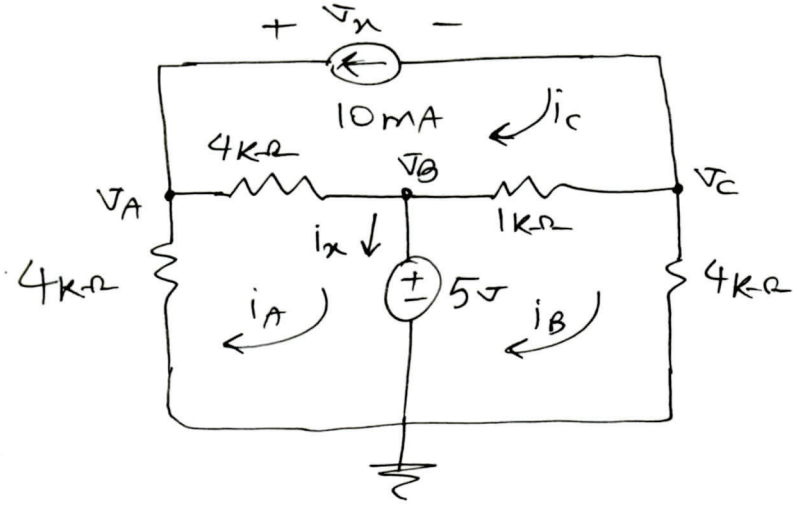
Note that in loop A, we have $i_A = i_s$

so for that row of matrix we have;

$$\begin{bmatrix} 1 & 0 & 0 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = i_s$$

3-5

(a)



$$\text{Mesh A:} \rightarrow \begin{bmatrix} (4+4)\times10^3 & 0 & -4\times10^3 \\ 0 & (1+4)\times10^3 & -1\times10^3 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_c \end{bmatrix} = \begin{bmatrix} -5 \\ 5 \end{bmatrix}$$

$$\text{Mesh B:} \rightarrow$$

$$i_c = -10\,mA$$

$$\Rightarrow i_A = -5.62\,mA,\ i_B = -1\,mA$$

(b)

$$V_A = -4i_A = 22.5V$$

$$V_C = 4i_B = -4V$$

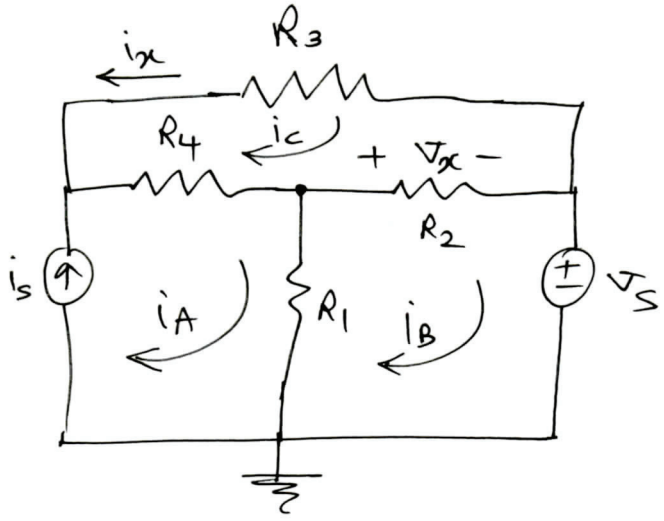
(c)

$$V_x = V_A - V_C = 22.5 + 4 = 26.5V$$

$$i_x = i_A - i_B = -4.62\,mA$$

3-6

(a)



$$\begin{matrix} \text{Mesh B:} \rightarrow \\ \text{mesh C:} \rightarrow \end{matrix} \begin{bmatrix} -R_1 & R_1+R_2 & -R_2 \\ -R_4 & -R_2 & R_2+R_3+R_4 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{pmatrix} -v_S \\ 0 \end{pmatrix}$$

$$i_A = i_S$$

(b) $i_A = i_S = 1\ mA$

$R_1 = R_2 = R_3 = R_4 = 10\ k\Omega$

$v_S = 25\ V$

$\Rightarrow$ $i_C = 0.1\ mA$, $i_B = -0.7\ mA$

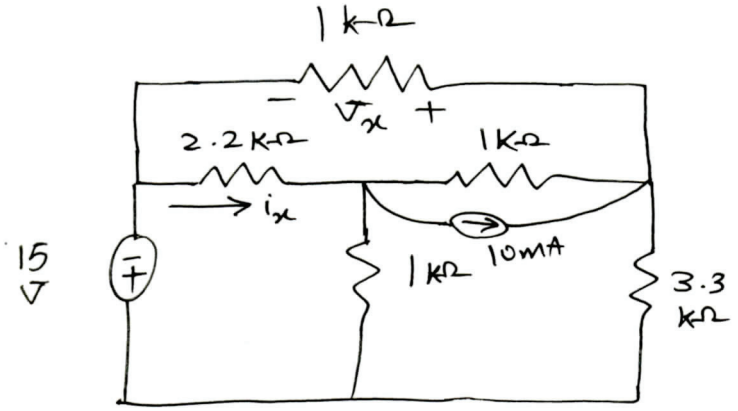
$\Rightarrow$ $i_x = -i_C = -0.1\ mA$

$v_x = 10(i_B - i_C)$

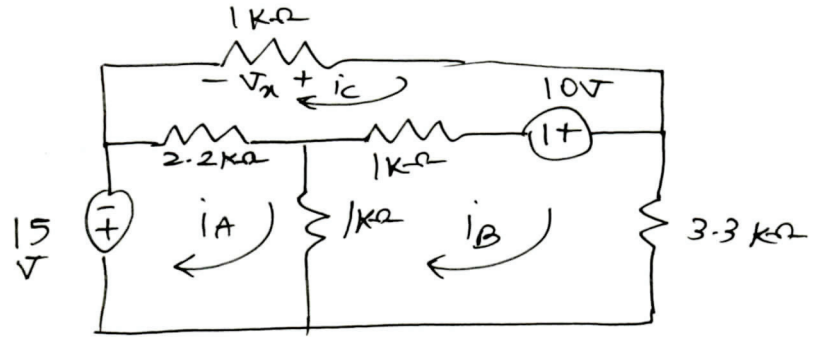
$= 10(-0.7-0.1) = -8\ V$

3-8

(a)



Source transformation



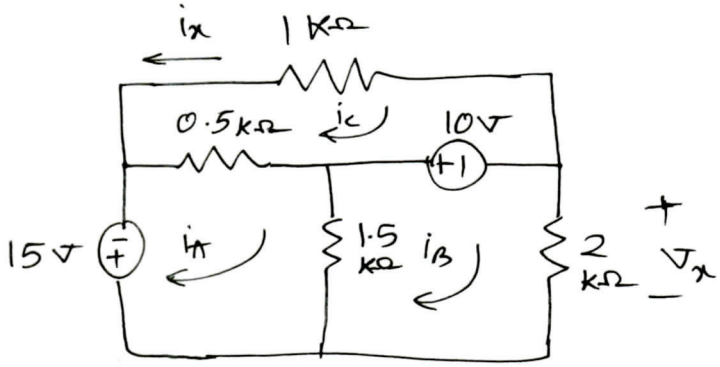
$$\begin{bmatrix} (2.2+1)\times10^3 & -1\times10^3 & -2.2\times10^3 \\ -1\times10^3 & (1+1+3.3)\times10^3 & -1\times10^3 \\ -2.2\times10^3 & -1\times10^3 & (1+1+2.2)\times10^3 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{bmatrix} -15 \\ 10 \\ -10 \end{bmatrix}$$

(b)

$$\left.\begin{aligned} i_A &= -11.29\ mA \\ i_B &= -1.89\ mA \\ i_C &= -8.74\ mA \end{aligned}\right\} \Rightarrow \begin{aligned} i_x &= i_A - i_C = -2.55\ mA \\ v_x &= -1\times i_C = 8.74\ V \end{aligned}$$

3-12

(a)



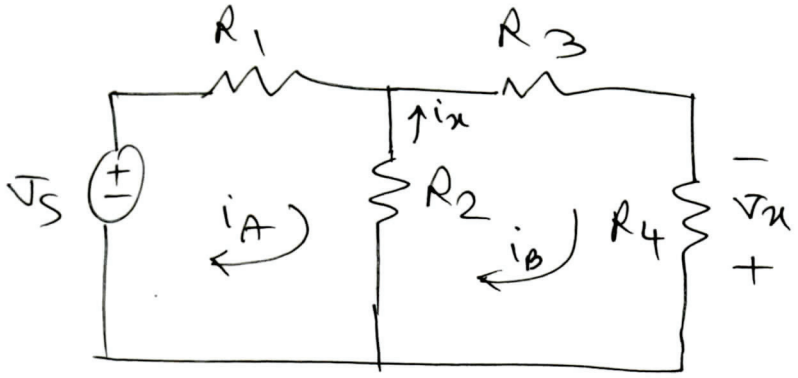
$$\begin{bmatrix} (0.5+1.5)\times10^3 & -1.5\times10^3 & -0.5\times10^3 \\ -1.5\times10^3 & (1.5+2)\times10^3 & 0 \\ -0.5\times10^3 & 0 & (1+0.5)\times10^3 \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_C \end{bmatrix} = \begin{bmatrix} -15 \\ -10 \\ +10 \end{bmatrix}$$

(b) $i_A = -13.4\,mA$

$i_B = -8.6\,mA$ $\Longrightarrow$ $i_x = -i_C = -2.2\,mA$

$i_C = +2.2\,mA$ $\quad v_x = 2\,i_B = -17.2\,V$

3-16



(a)

$$\begin{cases} R_1 i_A + R_2 i_A - R_2 i_B - V_S = 0 \\ -R_1 i_A + R_2 i_B + R_3 i_B + R_4 i_B = 0 \end{cases}$$

$$\underbrace{\begin{bmatrix} R_1+R_2 & -R_2 \\ -R_2 & R_2+R_3+R_4 \end{bmatrix}}_{A} \underbrace{\begin{bmatrix} i_A \\ i_B \end{bmatrix}}_{x} = \underbrace{\begin{bmatrix} +V_S \\ 0 \end{bmatrix}}_{b}$$

(b)

$$Ax = b \Longrightarrow x = A^{-1} b$$

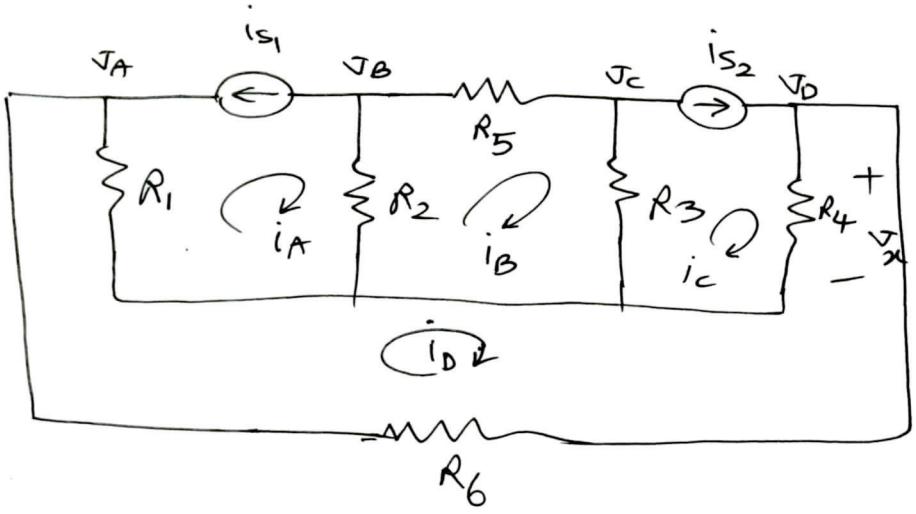
(c)

$$i_x = i_B - i_A$$

$$V_x = -R_4 i_B$$

3-21

(a)



(b)

$$\begin{cases} i_A = -i_{s_1} \\ -R_2 i_A + (R_2 + R_3 + R_5) i_B - R_3 i_C = 0 \\ i_C = i_{s_2} \\ -R_1 i_A - R_4 i_C + (R_1 + R_4 + R_6) i_D = 0 \end{cases}$$

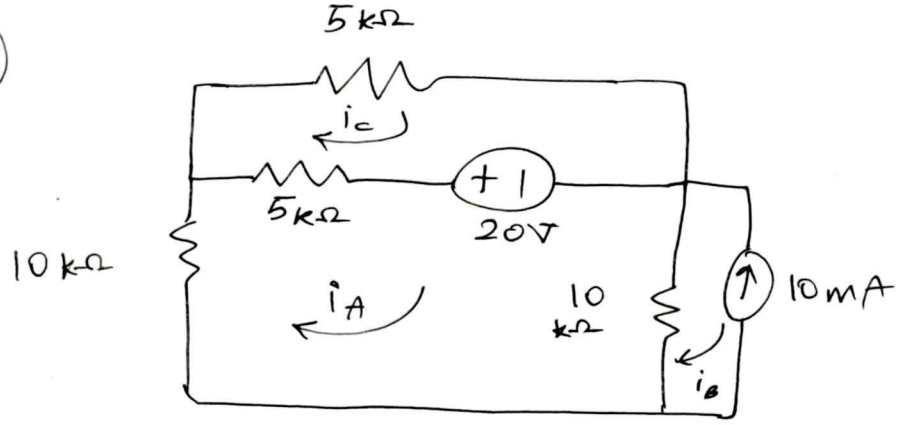
(c)

$$\left.\begin{array}{l} R_1 = R_2 = R_3 = R_4 = 4\,k\Omega \\ R_5 = R_6 = 2\,k\Omega \\ i_{s_1} = 80\,mA \\ i_{s_2} = 40\,mA \end{array}\right\} \Longrightarrow \begin{array}{l} i_A = -80\,mA \\ i_B = -16\,mA \\ i_C = 40\,mA \\ i_D = -16\,mA \end{array}$$

$$V_x = 4(i_C - i_D) = 4(40 + 16) = 224\,V$$

3-26

(a)



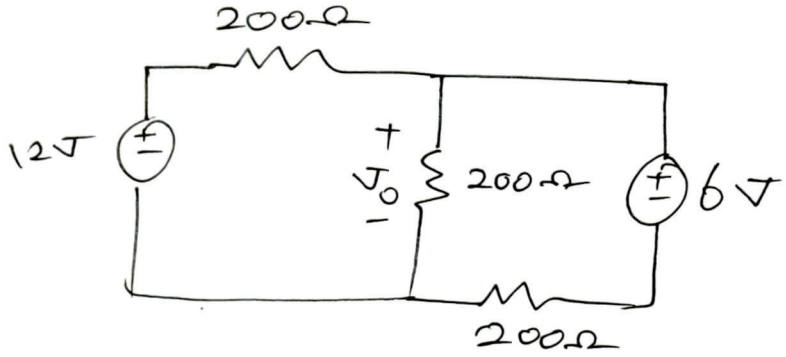
$$\text{Mesh A:} \rightarrow \quad \text{Mesh C:} \rightarrow \quad \begin{bmatrix} (10+5+10)\times10^{3} & -10\times10^{3} & -5\times10^{3} \\ -5\times10^{3} & 0 & 10\times10^{3} \end{bmatrix} \begin{bmatrix} i_A \\ i_B \\ i_c \end{bmatrix} = \begin{bmatrix} -20 \\ 20 \end{bmatrix}$$

$$i_B = -10\,mA$$

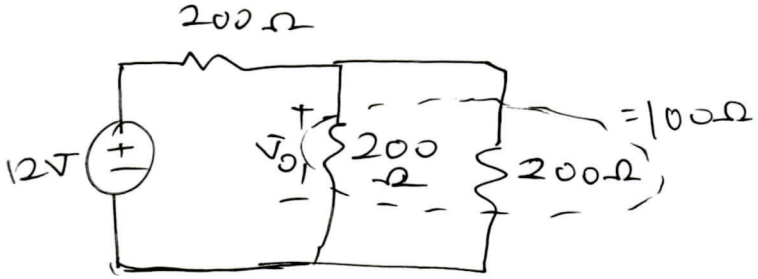
(d) $i_A = -4.88\ mA$

$i_c = -0.44\,mA$

3-36

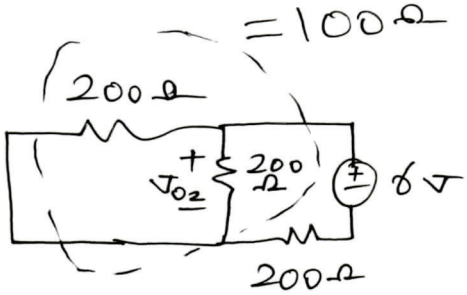


turn off "6V" Source:



$$\Rightarrow V_{o_1} = \frac{100 \times 12}{200+100} = 4V$$

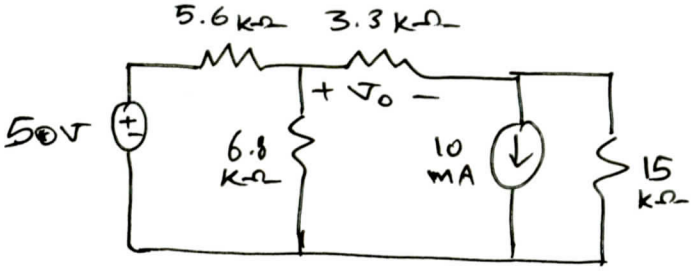
turn off "12V" Source!



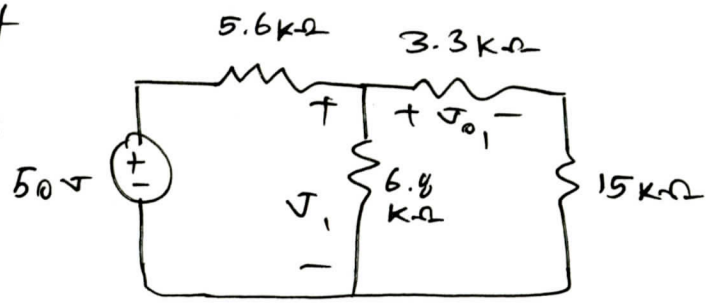
$$\Rightarrow V_{o_2} = \frac{100 \times 6}{200+100} = 2V$$

$$V_o = V_{o_1} + V_{o_2} = 4+2 = 6V$$

3-38



turn off current Source:

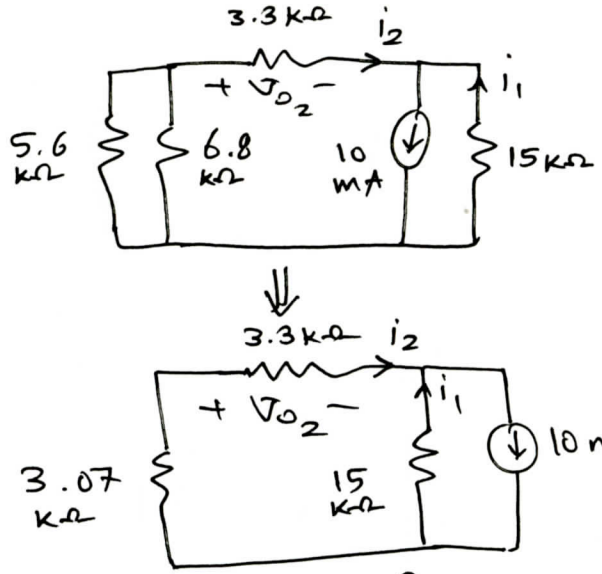


$$(3.3\times10^3+15\times10^3)\,||\,(6.8\times10^3)=4.95\ k\Omega$$

$$V_1=\frac{4.95\times10^3\times50}{5.6\times10^3+4.95\times10^3}=23.45V$$

$$V_{o_1}=\frac{3.3\times10^3\times23.45}{3.3\times10^3+15\times10^3}=4.22V$$

turn off voltage Source!



current division: $$i_2=\frac{15\times10^3\times10\,mA}{15\times10^3+3.3\times10^3+3.07\times10^3}=7.01\,mA$$

$$V_{o_2}=3.3\times10^3\times i_2=23.16V$$

$$V_o=V_{o_1}+V_{o_2}=4.22+23.16=27.38\ V$$