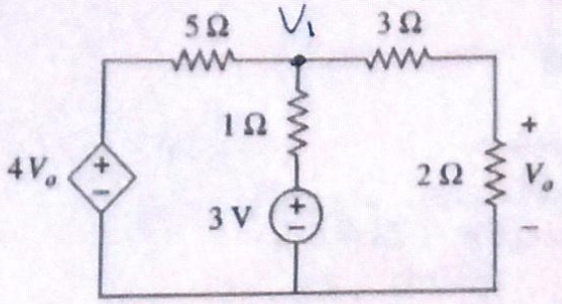
ENGR 12 TEST 2B NAME: SOLUTIONS

Closed Book, double sided sheet of notes allowed

1) Write the Nodal Equations needed to solve for Vo in the following circuit. Reduce your equations to matrix form suitable for entering into FreeMat. You do not have to solve the equations.



V_1: $\left[\frac{V_1 - 4V_o}{5} + \frac{(V_1 - 3)}{1} + \frac{V_1 - V_o}{3} = 0\right] \times 15$

$3V_1 - 12V_o + 15V_1 + 5V_1 - 5V_o = 45$

$-17V_o + 23V_1 = 45$

V_o: $\left[\frac{V_o - V_1}{3} + \frac{V_o}{2} = 0\right] \times 6$

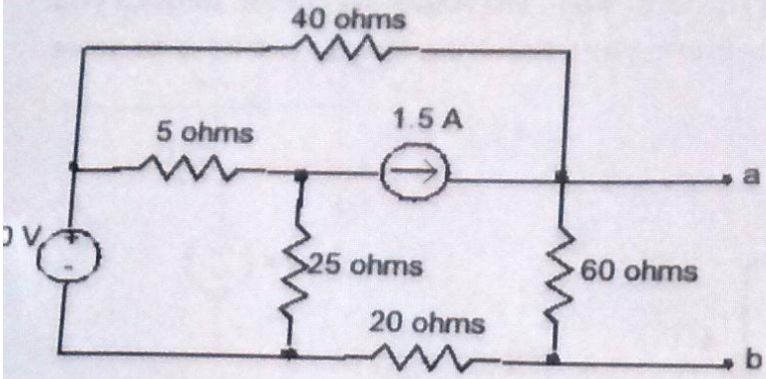
$2V_o - 2V_1 + 3V_o = 0$

$5V_o - 2V_1 = 0$

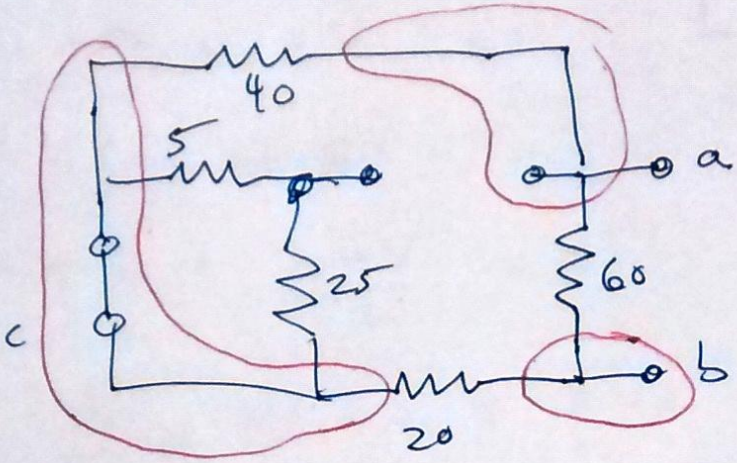
$$A = \begin{bmatrix} -17 & 23 \\ 5 & -2 \end{bmatrix}$$

$$B = \begin{bmatrix} 45 \\ 0 \end{bmatrix}$$

2) Find the Thèvenin or "lookback" resistance at a-b for the following circuit. You do not need to find the Thèvenin voltage.



TURN OFF INDEP SOURCES



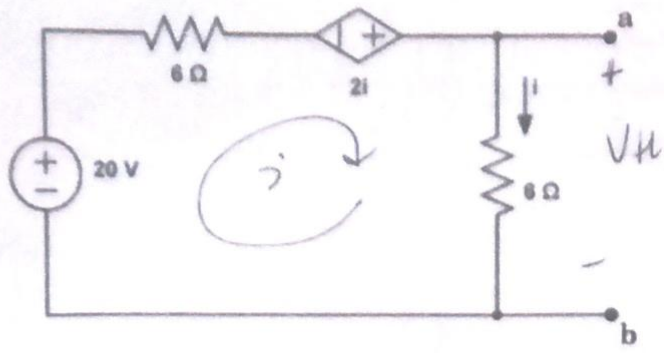
Find Rab

5 + 25 are parallel to a short cct

so you can ignore

$R_{ab} = (40 + 20) \| 60 = 30\ \Omega$

3) Find the Thèvenin equivalent circuit with respect to terminals *a* and *b*.



(1) Find Vth with Mesh Analysis

i is only mesh current

$-20 + 6i - 2i + 6i = 0$

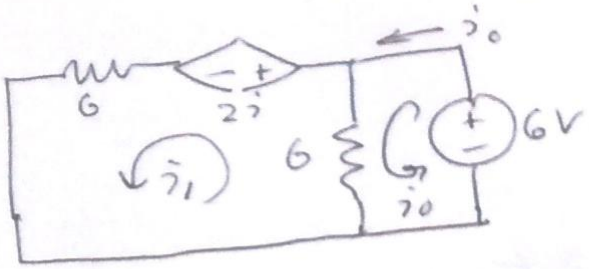
$10i = 20$

$i = 2A$

$\rightarrow V_{Th} = 6i = 12V$

(2) Find Rth - Turn off 20V src, connect 6V src

Find i_0, $R_{th} = \frac{6}{i_0}$



① $6(i_1 - i_0) + 2i + 6i_1 = 0$

$i = (i_0 - i_1)$

$-4i_0 + 10i_1 = 0$

② $-6 + 6(i_0 - i_1) = 0$

$i_0 - i_1 = 1$

$$\begin{bmatrix} -4i_0 + 10i_1 = 0 \\ 4i_0 - 4i_1 = 4 \end{bmatrix}$$

$6i_1 = 4$, $i_1 = \frac{2}{3}$, $i_0 = \frac{5}{3}$

$R_{th} = 6/5/3 = 18/5 = 3.6\Omega$

(turn over for problem 4)

Alternate: Find I_{NORTON}

$R_{TH} = \frac{V_{TH}}{I_N}$

Short at a-b $\rightarrow i = 0$

$\rightarrow 2i = 0$

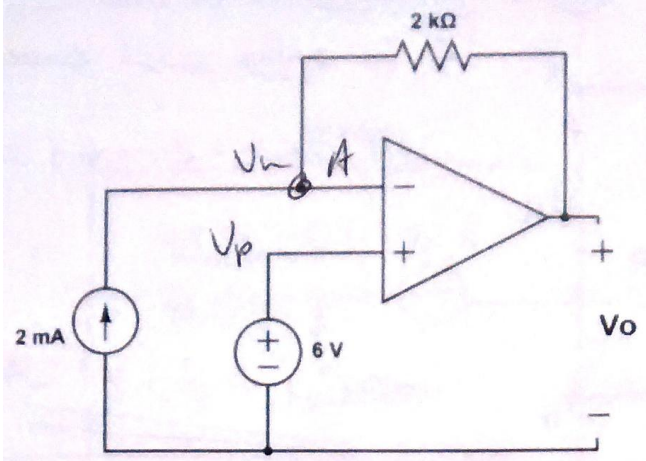
$\rightarrow I_N$ all the way around

$-20 + 6I_N = 0$

$I_N = \frac{20}{6} = \frac{10}{3}$

$R_{TH} = 12/10/3 = 3.6\Omega$

4) Find Vo for the ideal op-amp.



Negative Feedback

$\rightarrow V_p = V_n = 6V$

KCL at A:

$$+2 + \frac{V_o - V_n}{2} = 0$$

$$\frac{V_o}{2} = \frac{V_n}{2} - 2 = \frac{6}{2} - 2 = 2$$

$$\therefore V_o = 2.2 = 4V$$