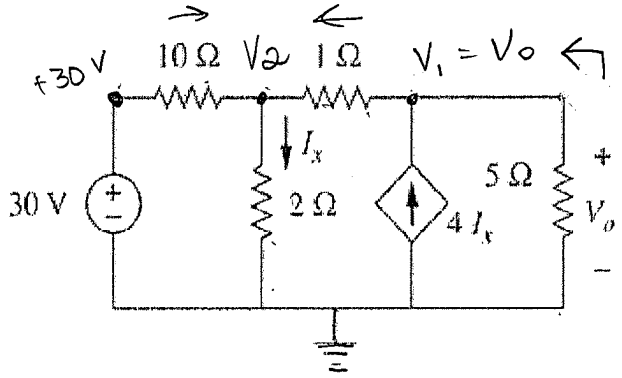
ENGR 12 TEST 2A 97 NAME: Emma Stavropoulos

Closed Book, one double sided sheet of notes allowed, and a calculator.
Time limit: 1 hour and 20 minutes.

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.



$V_1 = V_o$

$I_x = \frac{V_2 - 0}{2}$

$V_2)\quad \frac{30 - V_2}{10} + \frac{V_1 - V_2}{1} - I_x = 0$

$V_1)\quad -\frac{(V_1 - V_2)}{1} + \frac{0 - V_o}{5} + 4I_x = 0$

$V_2)\quad 30 - V_2 + 10V_o - 10V_2 - 5V_2 = 0$

$V_1)\quad -5V_o + 5V_2 - V_o + 10V_2 = 0$

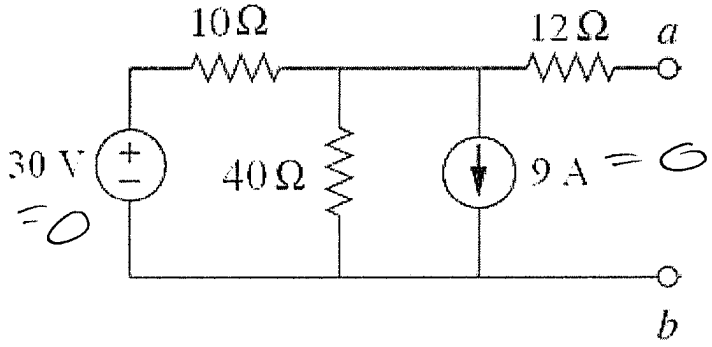
equations

$V_2)\quad -16V_2 + 10V_o = -30 \rightarrow -8V_2 + 5V_o = -15$

$V_1)\quad 15V_2 - 6V_o = 0 \rightarrow 5V_2 - 2V_o = 0$

Matrix $A = \begin{vmatrix} -8 & 5 \\ 5 & -2 \end{vmatrix}$ $b = \begin{vmatrix} -15 \\ 0 \end{vmatrix}$ $A \backslash b = \begin{bmatrix} V_2 \\ V_o \end{bmatrix}$

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



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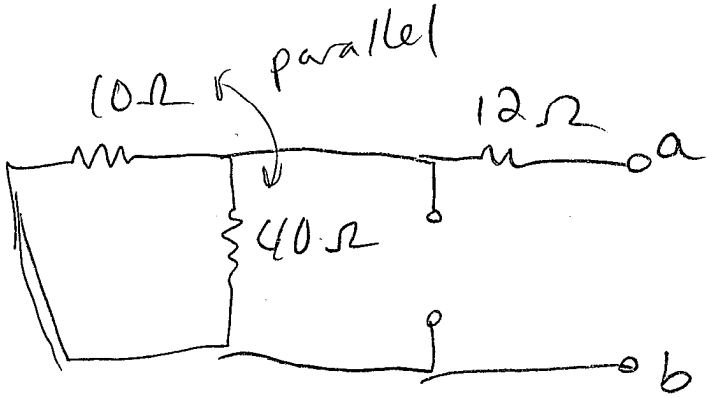
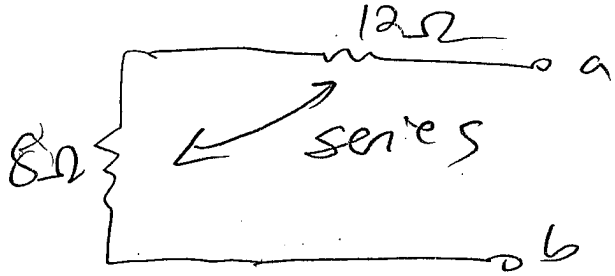


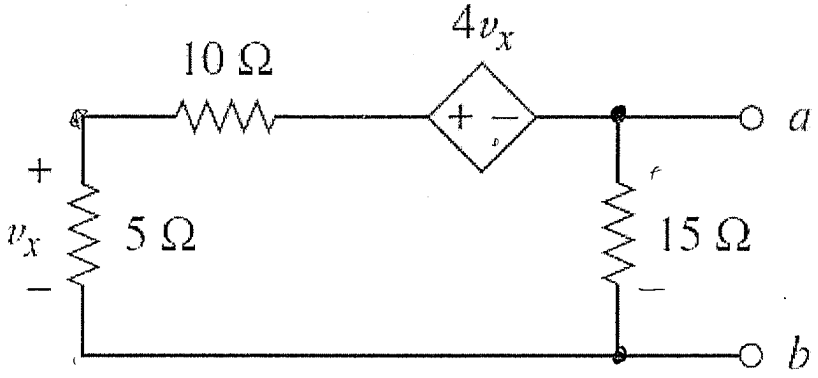
$\frac{4}{4}\frac{1}{10} + \frac{1}{40} = \frac{1}{R_{eq}} \Rightarrow \frac{5}{40} = \frac{1}{R_{eq}} \Rightarrow R_{eq} = 8\Omega$



$R_{th} = 20\Omega$

lookback resistance

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



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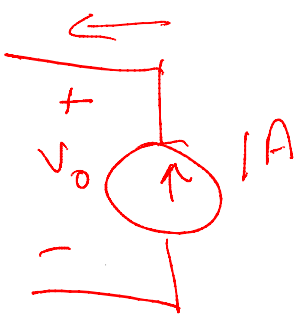


i_1) $5i_1 + 10i_1 + 4V_x + 15(i_1 - i_o) = 0$

$V_x = -5i_1$, $i_o = 1$

$15i_1 - 20i_1 + 15i_1 - 15 = 0$

$10i_1 = 15$

$i_1 = \frac{15}{10} = \frac{3}{2}$

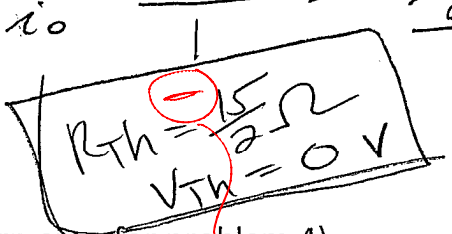
$V_o = 15(i_1 - i_o)$

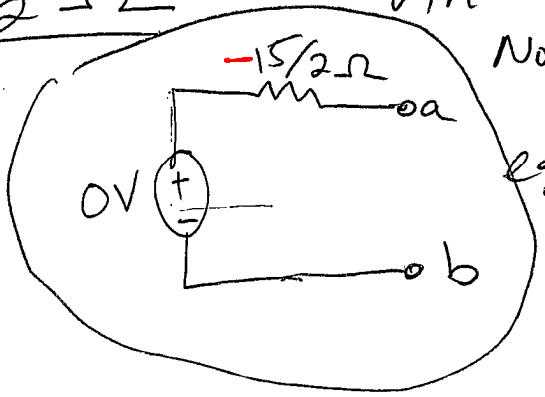
$V_o = 15\left(\frac{3}{2} - \frac{3}{2}\right) = 15\left(\frac{1}{2}\right)$

$R_{th} = \frac{V_o}{i_o} = \frac{15/2}{1} = \frac{15}{2}\ \Omega$

$V_{th} = 0$

No ind. sources



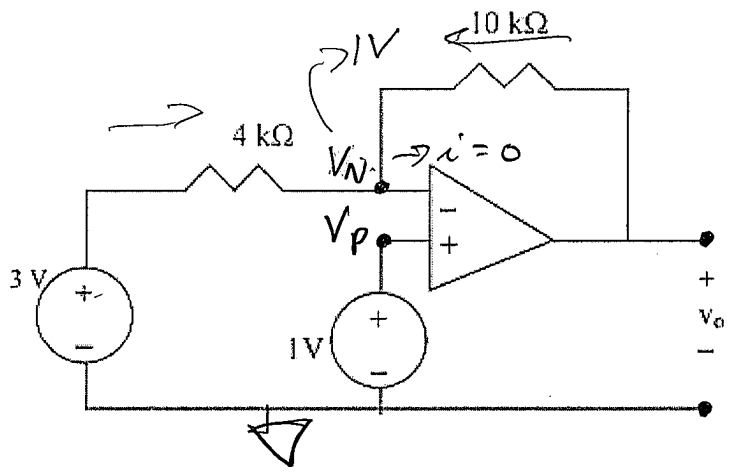


equivalent

(turn over for problem 4)

sign -3

4) Find Vo for the ideal op-amp.



$V_N = V_p = 1\,V$

KCL @ V_N

$$\frac{3 - V_N}{4} + \frac{V_o - V_N}{10} + 0 = 0 \quad , V_N = 1V$$

$$\frac{1}{2}\frac{2}{4} + \frac{V_o - 1}{10} = 0$$

$$5 + V_o - 1 = 0$$

$$V_o = -4V$$