Homework 1

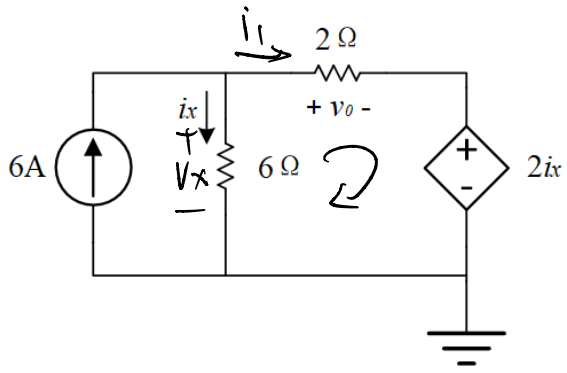
Due date: Oct. 8th, 2024 at 10 p.m.

Turn in your hard-copy hand-writing homework at the entrance of the School of Information, Room 3-324.

Rules:

- Work on your own. Discussion is permissible, but extremely similar submissions will be judged as plagiarism.
- Please show all intermediate steps: a correct solution without an explanation will get zero credit.
- Please submit on time. No late submission will be accepted.
- Please prepare your submission in English only. No Chinese submission will be accepted.

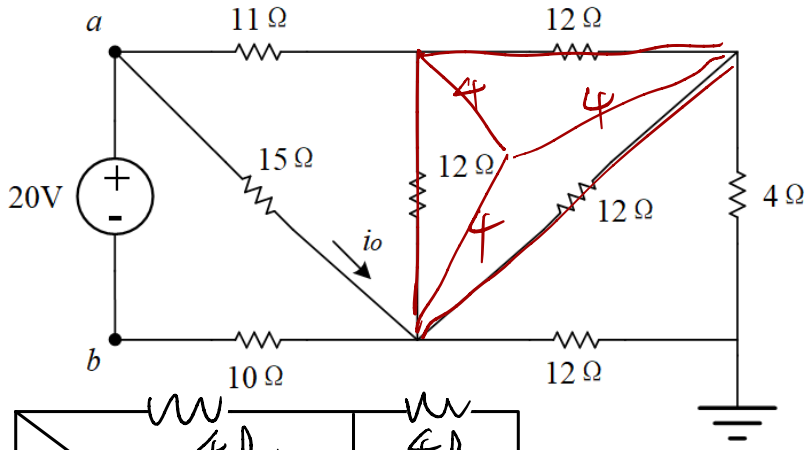
1. Find v_0 using Kirchoff's laws.



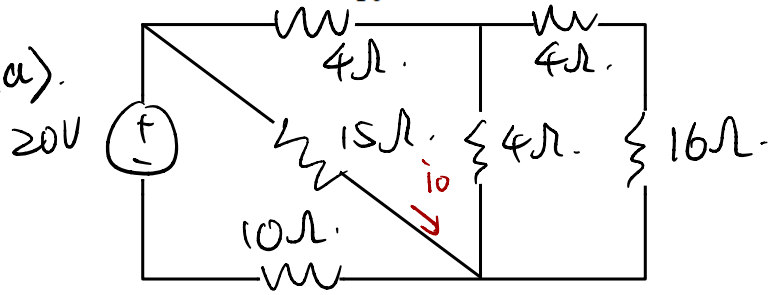
$$\begin{cases} -V_x + V_0 + 2i_x = 0 \quad \text{KVL.} \\ V_x = 6\,i_x \quad \text{Ohm.} \\ i_1 = \frac{V_0}{2} \quad \text{Ohm.} \\ 6 = i_x + i_1 \quad \text{KCL.} \end{cases}$$

$$\Rightarrow V_0 = 8\,V.$$

2. (a) Use Delta-to-Y or Y-to-Delta transformation to find the i_o in the circuit.
   (b) Calculate the equivalent resistance R_{ab}.



(a).



$R_Y = \frac{R_\Delta}{3} = 4\Omega.$

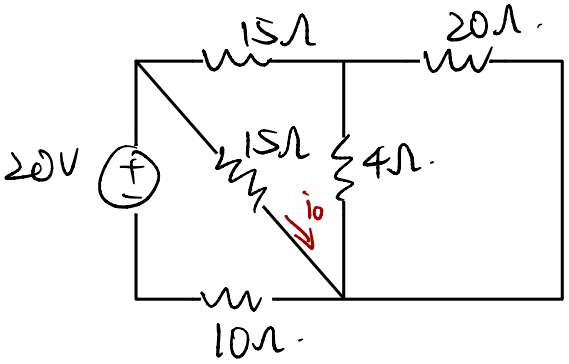
$4 + 16 = 20\Omega.$

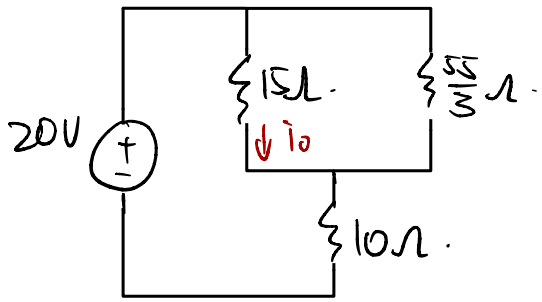
$11 + 4 = 15\Omega.$

$20 \parallel 4 = \frac{10}{3}\Omega.$

$15 + \frac{10}{3} = \frac{55}{3}\Omega.$

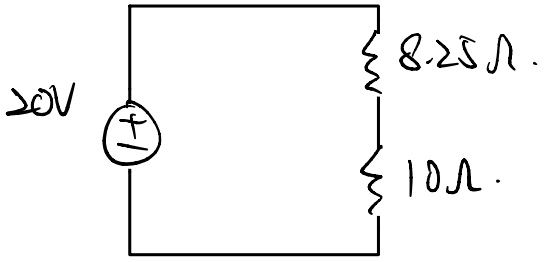
$\frac{55}{3} \parallel 15 = 8.25\ \Omega.$





$V_o = \frac{8.25}{8.25 + 10} \times 20 = 8.04\ V.$

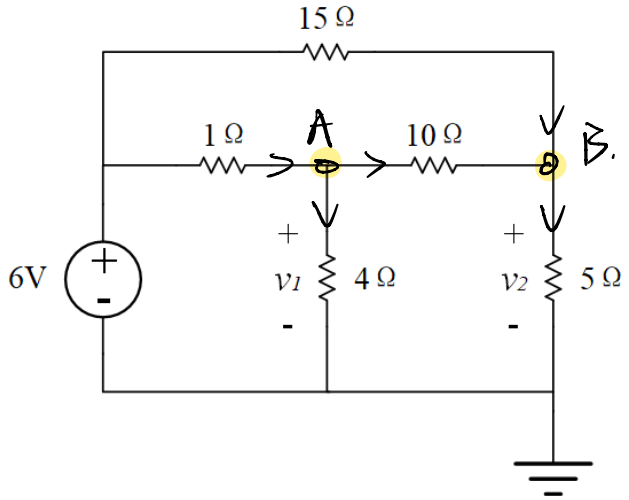
$i_o = \frac{V_o}{R_o} = \frac{8.04}{15} = 0.60\ A.$



(b). $R_{ab} = 10 + 8.25$

$= 18.25\ \Omega.$

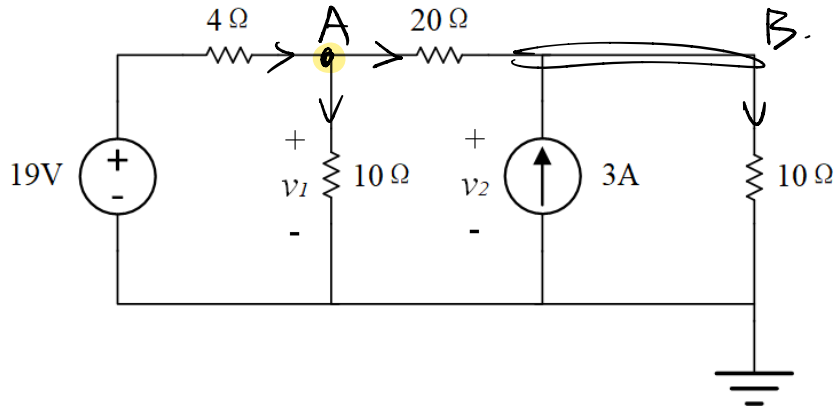
3. Use nodal analysis method to find v_1 and v_2 in the circuit.



KCL: $\begin{cases} \frac{6-V_1}{1} = \frac{V_1}{4} + \frac{V_1-V_2}{10} & \text{Node A.} \\ \frac{6-V_2}{15} + \frac{V_1-V_2}{10} = \frac{V_2}{5} & \text{Node B.} \end{cases}$

$\Rightarrow \begin{cases} V_1 = 4.62\,V \\ V_2 = 2.35\,V \end{cases}$

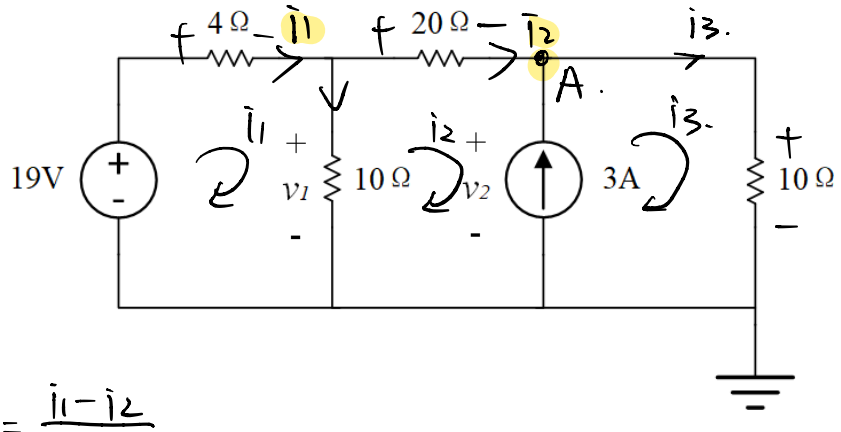
4. Use nodal analysis method to find v_1 and v_2 in the circuit.



KCL: $\begin{cases} \frac{19-v_1}{4} = \frac{v_1}{10} + \frac{v_1-v_2}{20} & \text{Node A.} \\ \frac{v_1-v_2}{20} + 3 = \frac{v_2}{10} & \text{Node B.} \end{cases}$

$\Rightarrow \begin{cases} v_1 = 15\ V \\ v_2 = 25\ V \end{cases}$

5. For the circuit below, use mesh current analysis method to find v_1 and v_2 in the circuit.



$v_1 = \frac{i_1 - i_2}{10}$.

Assume the voltage on the current source is V_2.

KVL: $-19 + 4 \cdot i_1 + 10(i_1 - i_2) = 0$. Mesh 1.

$-10(i_1 - i_2) + 20 \cdot i_2 + V_2 = 0$. Mesh 2.

$-V_2 + 10 \cdot i_3 = 0$. Mesh 3.

KCL: $i_2 + 3 = i_3$. Node A.

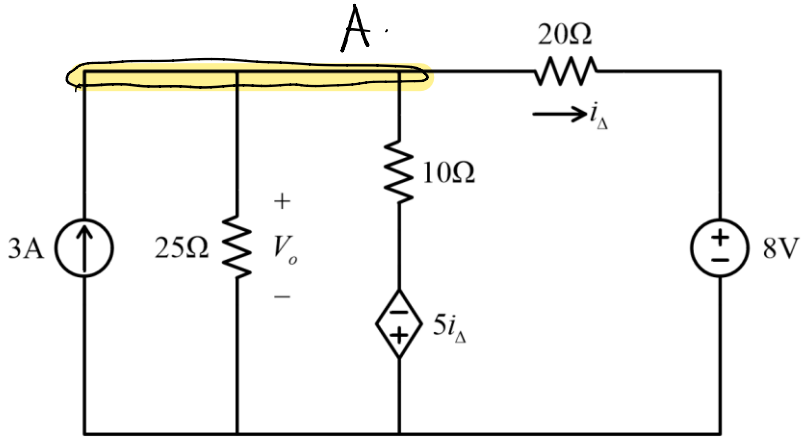
$\Rightarrow \begin{cases} V_1 = 15V. \\ V_2 = 25V. \end{cases}$

6. For the circuit below:

(a) Use the nodal method to find V_o in the circuit.

(b) Draw or copy the circuit on your own answer sheet, and use the mesh method to find V_o in the circuit.

(c) Find the power absorbed by the dependent source.



(a) KCL: $-3 + \frac{V_o}{25} + \frac{V_o + 5i_\Delta}{10} + \frac{V_o - 8}{20} = 0$. Node A.

Ohm: $i_\Delta = \frac{V_o - 8}{20}$.

$\Rightarrow V_o = 16.74\ V$

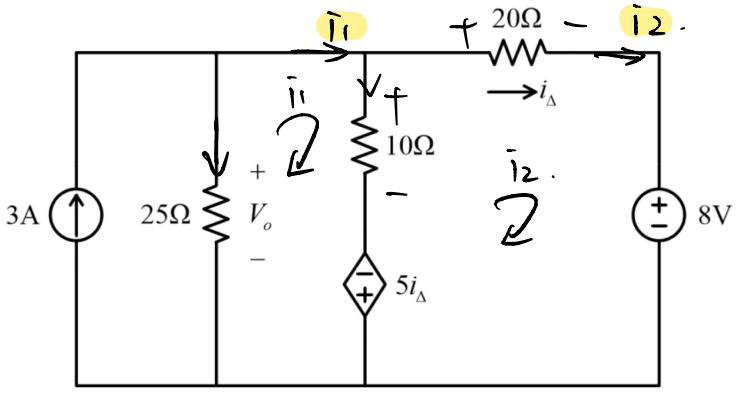
(b) KVL: $-25(3 - i_1) + 10\cdot(i_1 - i_2) - 5i_\Delta = 0$. Mesh 1.

$5i_\Delta - 10\cdot(i_1 - i_2) + 20 i_2 + 8 = 0$. Mesh 2.

$i_\Delta = i_2$.

$V_o = 25\cdot(3 - i_1)$.

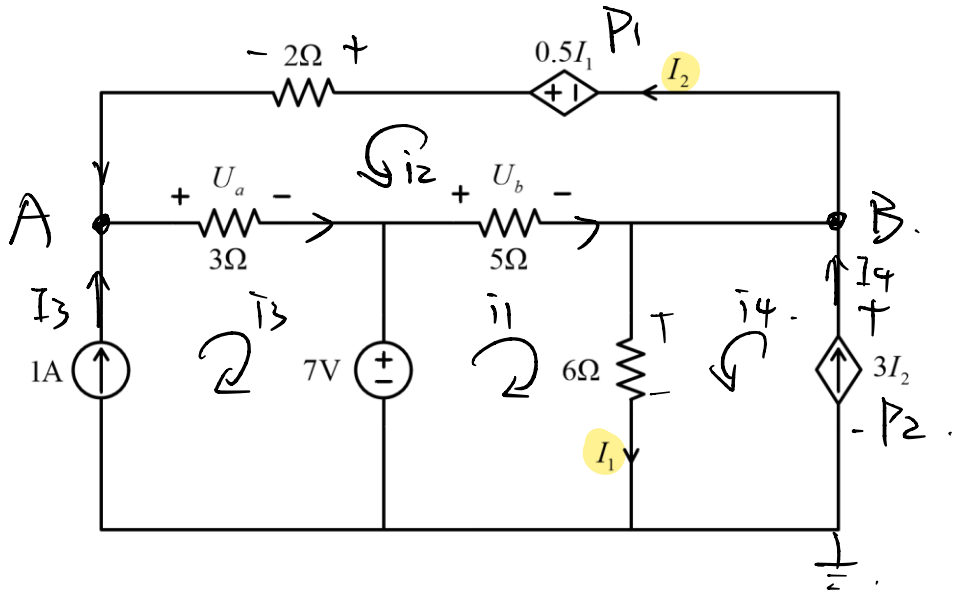
$\Rightarrow V_o = 16.74\ V$.



(c). $i_{ds} = \frac{V_o + 5i_o}{10} \Rightarrow i_o = 0.44\ A.$

$\Rightarrow P_{ds} = (-5i_o) \cdot i_{ds} = -4.14\ W.$

7. Use mesh analysis to find U_a, U_b and the power delivered by the two controlled sources.



Assume $I_3 = 1A$, $I_4 = 3I_2$.

KVL: $-0.5I_1 + 2\cdot I_2 + 3\cdot(I_2 + I_3) + 5\cdot(I_1 + I_2 - I_4) = 0$. Mesh 1.

$5\cdot(I_1 + I_2 - I_4) + 6I_1 - 7 = 0$. Mesh 2.

Also. $U_a = 3\cdot(I_2 + I_3)$.

$U_b = 5\cdot(I_1 + I_2 - I_4)$.

$$\Rightarrow \begin{cases} I_1 = 6.5A \\ I_2 = 6.45A \\ U_a = 22.35\,V \\ U_b = -32\,V \end{cases} \Rightarrow \begin{cases} P_1 = 0.5I_1 \times I_2 = 20.96\,W \\ P_2 = 3I_2 \times 6I_1 = 754.65\,W \end{cases}$$