VE215 2024FA Assignment 1

Due Date: 23:59, Oct.28th, 2024

In order to get full marks, you shall write all the intermediate steps of calculation or proof unless otherwise indicated. This assignment covers content from chapter 1 to 3.

Exercise 1.1 (20%)

The current entering the positive terminal of a device is i(t) = $2e^{-2t}mA$ and the voltage across the device is v(t) = $15\frac{di}{dt}V$.

(a) Find the total charge in the device at t = 3 s, q(0)=0.

(b) Calculate the power absorbed P(t).

(c) Determine the total energy absorbed in 5s.

(a) $q = \int_0^3 2e^{-2t}\,dt + q_0$.

$= -\int_0^3 e^{-2t}\,d(-2t) + 0$

$= e^{-2t}\Big|_0^3$

$= (-e^{-6} + 1)$

$= 0.9975\ mC$.

(2) $\frac{di}{dt} = -4\cdot e^{-2t}$.

$V(t) = -60\cdot e^{-2t}$

$P(t) = V(t)\,i(t)$

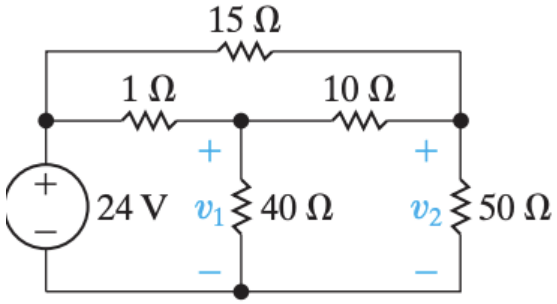
$= 0.12e^{-2t}\ W$.

(3) $W = \int_0^5 P(t)\,dt$.

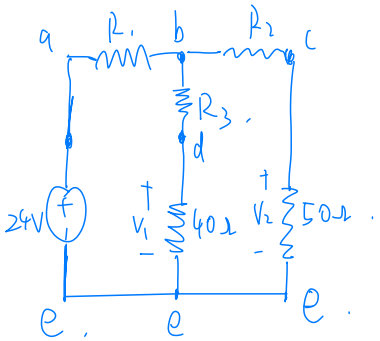
$= \int_0^5 0.12e^{-4t}\,dt$.

$= 0.03e^{-4t}\Big|_0^5 = 0.03(e^{-20} - 1) \approx -0.03$ J

Exercise 1.2 (20%) Please find the voltage v_1 and v_2 in the circuit below by using delta-to-wye transformation.



We can get the equivalent, by delta to w



$R_1 = \frac{15\times1}{15+1+10} = \frac{15}{26}\ \Omega$.

$R_2 = \frac{15\times10}{15+1+10} = \frac{75}{13}\ \Omega$.

$R_3 = \frac{1\times10}{15+1+10} = \frac{5}{13}\ \Omega$.

$R_p = \frac{(\frac{5}{13}+40)\,|\,(\frac{75}{13}+50)}{\frac{5}{13}+\frac{75}{13}+90} = \frac{60?}{26}\ V$.

$V_p = 24\,\frac{\frac{60?}{26}}{\frac{60?}{26}+\frac{15}{26}} = \frac{60?}{26}\cdot V$

$V_1 = \frac{60?}{26}\cdot\frac{40}{\frac{5}{13}+40} = 23.2V$.

$V_2 = \frac{60?}{26}\cdot\frac{50}{\frac{75}{13}+50} = 21V$

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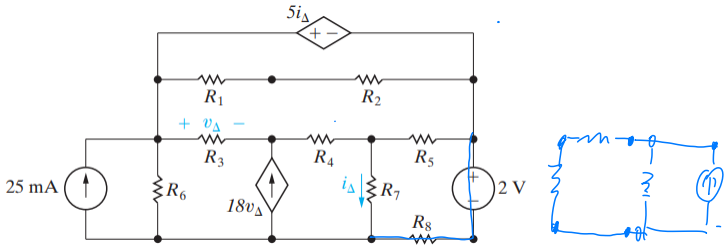
Exercise 1.3 (20%)

In the network graph below

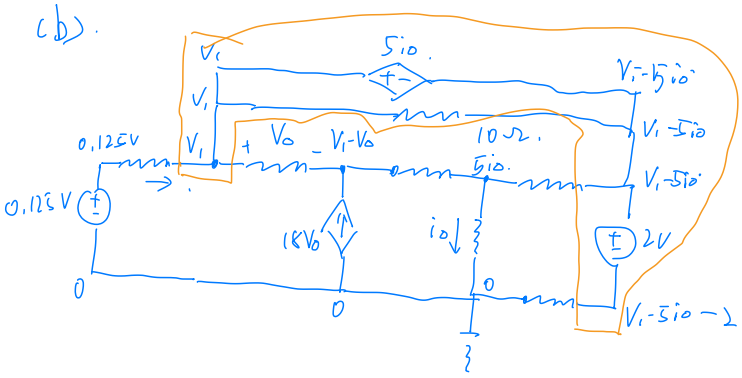
(a) Determine the number of branches, nodes and meshes.

(b) Assuming all the resistor have the resistance of 5 ohm, calculate out $v_\triangle$ and $i_\triangle$



(a). Branches: 12 meshes: 6. nodes: 7.

(b).



$$\frac{0.125-V_1}{5}+\frac{2+5i_o-V_1}{5}-\frac{V_o}{5}+\frac{10i_o-V_1}{5}=0.$$

$$\begin{cases} 18V_\Delta+\frac{V_o}{5}+\frac{5i_o+V_o-V_1}{5}=0. \\ \frac{5i_o+V_o-V_1}{5}+i_\Delta+\frac{10i_o-V_1}{5}=0. \end{cases}$$

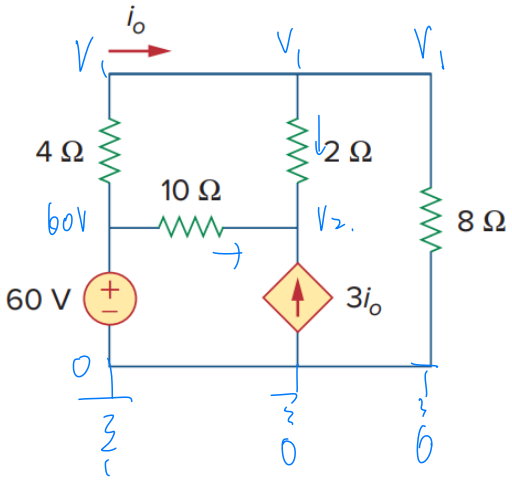
$V_o = 7.67\times10^{-3}$ V.

$V_1 = 1.4$ V.

$i_o = 0.14$ A.

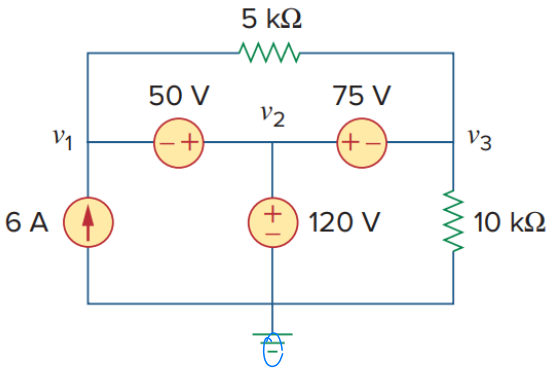
Exercise 1.4 (10+10%)

(a) (10%) Using nodal analysis, find current i_0 in the circuit below.



$$\begin{cases} \frac{60-V_1}{4} + \frac{V_2-V_1}{2} - \frac{V_1}{8} = 0 \\ \frac{V_1-V_2}{2} + \frac{60-V_2}{10} + 3i_0 = 0 \\ i_0 = \frac{V_1-V_2}{2} + \frac{V_1}{8} \end{cases} \Rightarrow \begin{cases} V_1 = 50.3\,V \\ V_2 = 58.0\,V \\ i_0 = 2.43\,A \end{cases}$$

(b) (10%) Obtain the node voltages v_1, v_2, and v_3 in the circuit below.



$V_2 = 120\,V$

$V_1 = 70\,V$

$V_3 = 45\,V$

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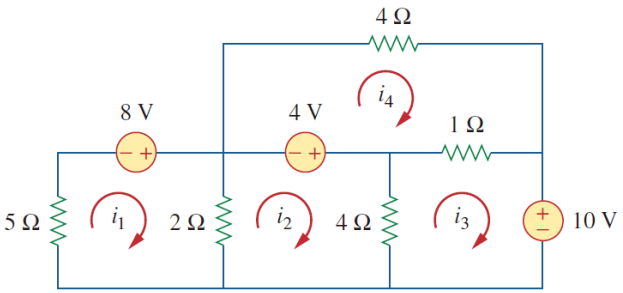
Exercise 1.5 (10+10%)

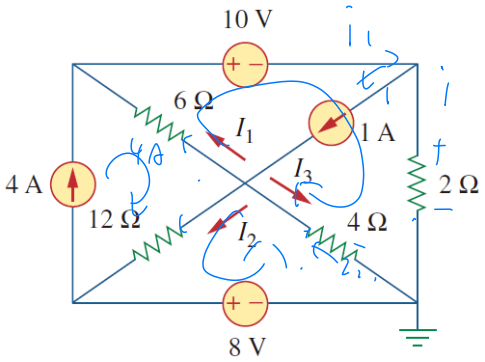
(a) (10%) Use mesh analysis **by inspection** to find current i_1, i_2, i_3 and i_4 in the circuit below.



$$\begin{cases} 5i_1 - 8 + (i_1 - i_2)\cdot 2 = 0 \\ 2(i_2 - i_1) - 4 + 4(i_2 - i_3) = 0 \\ 4(i_3 - i_2) + (i_3 - i_4) + 10 = 0 \\ i_4 - i_3 + 4 + 4i_4 = 0 \end{cases}$$

$$\begin{cases} i_1 = 0.77\,A \\ i_2 = -1.5\,A \\ i_3 = -3.3\,A \\ i_4 = -1.47\,A \end{cases}$$

(b) (10%) Find current I_1, I_2 and I_3 in the circuit below.



$$\begin{cases} 6(i_1 - 4) + 10 - 2i_3 + 4(i_1 - i_3) = 0 \\ 12(i_2 + 4) + 8 + 4(i_2 - i_3) = 0 \\ i_1 + i_3 = 1 \end{cases}$$

$$\begin{cases} i_1 = 3\,A \\ i_2 = -4\,A \\ i_3 = -2\,A \end{cases}$$

$$\begin{cases} I_1 = i_1 - 4 = -1\,A \\ I_2 = i_2 + 4 = 0\,A \\ I_3 = i_3 - i_2 = 2\,A \end{cases}$$