ZJU-UIUC INSTITUTE

Zhejiang University – University of Illinois at Urbana-Champaign Institute

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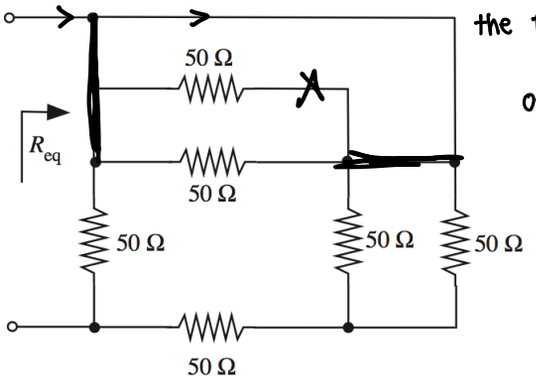
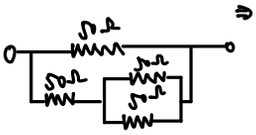
ECE-210 Analog Signal Processing Spring 2022
Homework #2: Submission Deadline 2nd March (10:00 PM)

1. Find R_{eq} for the following circuit



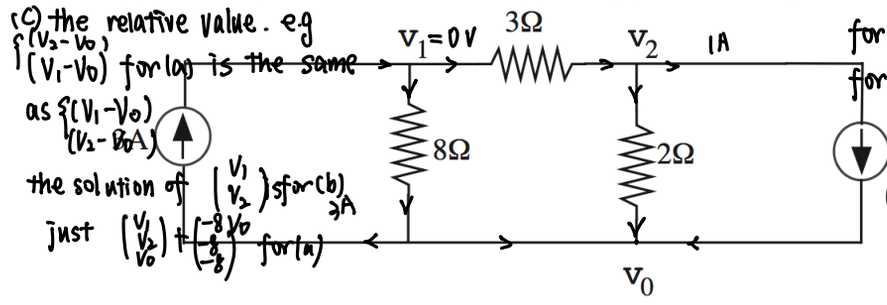
the total ckt can be converted into



$\Rightarrow R_{eq} = \frac{75\Omega \times 50\Omega}{125\Omega} = 30\Omega$

2. Consider the circuit below
   (a) Write nodal equations for the circuit below, assuming that v_0 = ground. Solve for v_1 and v_2.
   (b) Write nodal equations for the same circuit, but this time, assume that v_1 = ground. Solve for v_0 and v_2.
   (c) How are your answers to parts (a) and (b) related?

(c) the relative value. eg (V_2-V_0), (V_1-V_0) for loop is the same as (V_1-V_0), (V_2-8)A, the solution of $\begin{pmatrix} V_1 \\ V_2 \end{pmatrix}$ for (b) is just $\begin{pmatrix} V_1 \\ V_2 \\ V_0 \end{pmatrix} + \begin{pmatrix} -8 \\ -8 \\ 8 \end{pmatrix}$ for (a)



(a) nodal equations:

for V_1: $3A = \frac{(V_1-V_2)}{3\Omega} + \frac{V_1}{8\Omega} \Rightarrow V_1 = 8V$

for V_2: $\frac{(V_1-V_2)}{3\Omega} = 1A + \frac{V_2}{2\Omega} \Rightarrow V_2 = 2V$

(b) for V_0: $\left(\frac{V_2-V_0}{2\Omega}\right) + \left(\frac{0-V_0}{8} - 3\right) + 1A = 0$

for V_2: $\left(\frac{0-V_2}{3\Omega}\right) = 1A + \left(\frac{V_2-V_0}{2\Omega}\right)$

$\Rightarrow V_0 = -8$, $V_2 = -6V$

3. Consider the following circuit
   (a) Use the node-voltage method to obtain a set of equations, in terms of the node voltages, that can be solved to obtain all node voltages using the bottom node as the reference node.
   (b) Use the loop-current method to obtain a set of equations, in terms of loop currents, that can be solved to obtain all loop currents.
   (c) Obtain all node voltages.
   (d) Obtain all loop currents.
   (e) Use superposition to obtain the voltage across the terminals of the current source.
   (f) Obtain the power absorbed by the current source

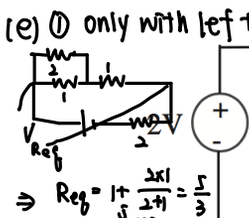
(a) for node voltage method.

for V_1: $1A + \frac{(2V-V_1)}{2\Omega} = \frac{(V_1-V_2)}{1\Omega}$

for V_2: $\frac{(V_1-V_2)}{1\Omega} + \frac{V_0-V_2}{2\Omega} = \frac{V_2}{1\Omega} \Rightarrow$ (c) $V_0 = 0$ V, $V_1 = \frac{24}{11}$ V, $V_2 = \frac{14}{11}$ V

for V_3: $V_3 + 2 = V_2$, $V_3 = \frac{-8}{11}$ V

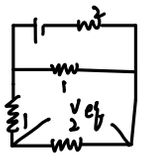
(e) ① only with left 2Volt



$\Rightarrow R_{eq} = 1 + \frac{2\times1}{2+1} = \frac{5}{3}$

$\Rightarrow V_{eq} = \frac{\frac{5}{3}\times2}{\frac{5}{3}+2} = \frac{10}{11}$ V

② only with right 2Volt



$R_{eq} = \frac{1\times3}{1+3} + 2 = \frac{3}{4} + 2 = \frac{11}{4}\Omega$

$\Rightarrow V_{eq} = \frac{2}{\frac{11}{4}} \times \frac{3}{4} \times \frac{2}{3} = \frac{8}{11} \times \frac{1}{2} = \frac{4}{11}$ V

(b) for i_1: $2\Omega \cdot i_1 + (V_1) = 2V$

for i_2: $1\Omega \cdot i_2 + 1\Omega \cdot i_2 = 1 \cdot i_3 + V_1$

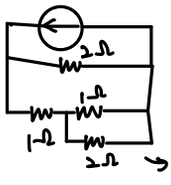
for i_3: $2V + 2\Omega \cdot i_3 + 1\Omega \cdot i_3 = 1\Omega \cdot i_2$

$i_2 - i_1 = 1A$

(d) $\Rightarrow i_1 = -\frac{1}{11}$A, $i_2 = \frac{10}{11}$A, $i_3 = -\frac{4}{11}$A, $V_1 = \frac{24}{11}$ V

(a) $V_0 = 0$

③ only with current source



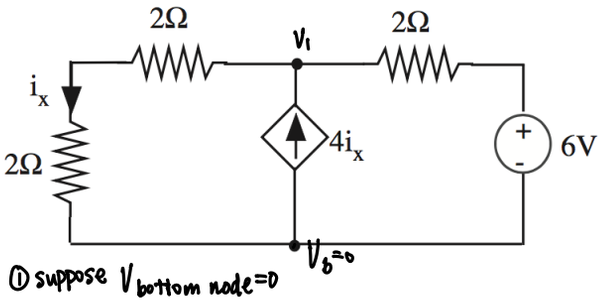
$Req_2 = \frac{2\times\frac{5}{3}}{2+\frac{5}{3}} = \frac{\frac{10}{3}}{\frac{11}{3}} = \frac{10}{11}\Omega$

$Req_1 = \frac{1\times2}{1+2} + 1 = \frac{5}{3}$

$\Rightarrow V = 1 \times \frac{10}{11}\Omega = \frac{10}{11}$ V $\Rightarrow \sum V_{\text{current source}} = 10/11 + 10/11 + 4/11 = \frac{24}{11}$ V

(f) $P_{absorb} = (-1A) \times \frac{24}{11}$ V $= -\frac{24}{11}$ W

4. Find i_x using nodal analysis.



① suppose $V_{\text{bottom node}}=0$

$$\Rightarrow \begin{cases} I_x = 4i_x + \dfrac{(6-V_1)}{2} \\ \dfrac{V_1}{4} = i_x \end{cases} \Rightarrow 4i_x = V_1$$

$$\therefore i_x = 4i_x + 3 - 2i_x$$

$$\therefore i_x = -3A$$