EECS 16A Dis 5A Notes

Sunday, September 26, 2021 4:57 PM

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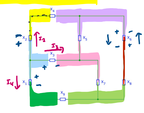
1. Label the circuit

In the circuit shown below, label all the nodes, and show one possible way of labeling all the element voltages and currents following the passive sign convention.

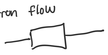


7 nodes

Voltage: diff in potential

Current: Electron flow

Circuit element:



Passive sign convention:

Voltage Source:

I_S = ?

Current Source

V_S = ?

Wire:

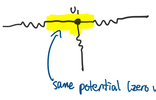
Resistor:

Ohm's Law: $V_R = I_R \cdot R$ ← resistance

Voltage drop

Current going through resistor

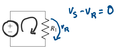
Node: Place where ≥2 ckt elements meet



same potential (zero voltage)

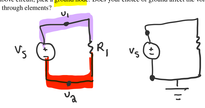
2. A Simple Circuit

For the circuit shown below, find the voltages across all the elements and the currents through all the elements.

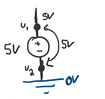


$V_S - V_R = 0$

(a) In the above circuit, pick a ground node. Does your choice of ground affect the voltage across and the current through elements?



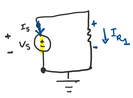
Ground: Reference point



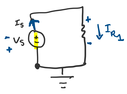
"v_1 is 5V higher than v_2"

(b) With your choice of ground, label the node potentials for every node in the circuit.

(c) Label all of the branch currents. Does the direction you pick matter?

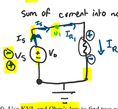


(d) Draw the +/− labels on every element. What convention must you follow?



(e) Use KCL to find an equation for the unknown currents.

Sum of current into node = Sum of current going out of node

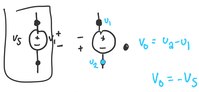


$I_S = I_{R_1}$ $I_S - I_{R_1} = 0$

(f) Use KVL and Ohm's law to find two equations for the unknown node potentials and currents.

$V_S - V_R = 0$ Ohm's Law: $V_R = I_R \cdot R$

KVL: Sum of voltages in a loop = 0



$V_0 = v_2 - v_1$

$V_0 = -V_S$

$V_R = v_1 - 0V$

$V_R = v_1$

$V_0 = 0V - v_1$

$V_0 = -v_1$

$V_S = v_1$

$V_R = v_1 = V_S$

$V_1 = v_1 - v_2$

$= V_S$

$V_R = I_R \cdot R = V_S$ $I_R = \frac{V_S}{R}$

(g) Solve the system of equations if $V_S = 5$ V and $R_1 = 5\,\Omega$.

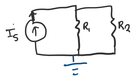
$V_S = v_1 = 5V$

$I_R = \frac{V_S}{R} = \frac{5V}{5\Omega} = 1\,A = I_R$

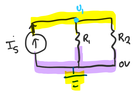
3. A Slightly More Complicated Circuit

For the circuit shown below, find the voltages across all the elements and the currents through all the elements.

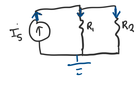
(a) In the above circuit, pick a ground node. Does your choice of ground matter?



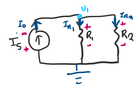
(b) With your choice of ground, label the node potentials for every node in the circuit.



(c) Label all of the branch currents. Does the direction you pick matter?



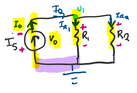
(d) Draw the +/− labels on every element. What convention must you follow?



(e) Set up a matrix equation in the form $A\vec{x} = \vec{b}$ to solve for the unknown node potentials and currents. What are the dimensions of the matrix A? Hint: you don't need to fill out the elements of A or b in this part of the question.

4×4 matrix 4×1 4×1

(f) Use KCL to find as many equations as you can for the matrix.



$I_0 = I_{R_1} + I_{R_2}$

$I_0 - I_{R_1} - I_{R_2} = 0$

$\begin{bmatrix} 1 & -1 & -1 & 0 \end{bmatrix} \begin{bmatrix} I_0 \\ I_{R_1} \\ I_{R_2} \\ v_1 \end{bmatrix} = \begin{bmatrix} 0 \end{bmatrix}$

(g) Use KVL and Ohm's law to find the remaining equations for the matrix.

From part f, $I_0 - I_{R_1} - I_{R_2} = 0$

Ohm's Law: $V_R = I_R \cdot R$

$V_{R_1} = I_{R_1} \cdot R_1$

$V_{R_2} = I_{R_2} \cdot R_2$

$v_1 - 0 = V_{R_1}$

$v_1 = V_{R_1}$

$v_1 = I_{R_1} \cdot R_1$

$v_1 - R_1 \cdot I_{R_1} = 0$

$v_1 - 0 = V_{R_2}$

$v_1 = I_{R_2} \cdot R_2$

$v_1 - R_2 \cdot I_{R_2} = 0$

$I_0 = I_S$

$\begin{bmatrix} 1 & -1 & -1 & 0 \\ 0 & -R_1 & 0 & 1 \\ 0 & 0 & -R_2 & 1 \\ 1 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} I_0 \\ I_{R_1} \\ I_{R_2} \\ v_1 \end{bmatrix} = \begin{bmatrix} 0 \\ 0 \\ 0 \\ I_S \end{bmatrix}$

(h) Solve the system of equations if $I_S = 5$ A, $R_1 = 5\,\Omega$, and $R_2 = 10\,\Omega$.

$\begin{bmatrix} 5\,A \\ 3.33\,A \\ 1.67\,A \\ 16.67\,V \end{bmatrix} = \begin{bmatrix} I_0 \\ I_{R_1} \\ I_{R_2} \\ v_1 \end{bmatrix}$