1. Passive Sign Convention and NVA Basics

The following question is a modified version of Spring 2022 Midterm 2 Question 1

Suppose we have the following circuit:

(a) Following passive sign convention, **label** the missing currents and the missing voltages for each element in the circuit, including the voltage source.

(b) **Write the KCL expression** at node $u_5$ in terms of currents $I_3$, $I_4$, and $I_6$ as labeled in the circuit diagram.
(c) Find the voltage across $R_4$, $R_5$, and $R_6$ in terms of the node voltages $u_3$, $u_4$, and $u_5$. Then use Ohm’s law to express the currents across $R_4$, $R_5$, and $R_6$ in terms of node voltages and resistances.

(d) Write the KVL expression for the loop drawn in the circuit diagram in terms of voltages $V_5$, $V_1$, and $V_2$.

2. A Simple Current 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 reference node. Does your choice of reference matter?
(b) With your choice of reference, 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 as many equations as you can.
(f) Use KVL and Ohm’s law to find the remaining equations to solve the circuit.

(g) Solve for the voltages across both resistors and the currents going through them if $I_S = 5 \, \text{A}$, $R_1 = 5 \, \Omega$, and $R_2 = 10 \, \Omega$.

(h) (OPTIONAL) Rather than solve for the system using substitution, we can also use matrices! Set up a matrix equation in the form $A\vec{x} = \vec{b}$ to solve for the unknown node potentials and currents, which are $I_0, I_1, I_2$ and $u_1$. Then use part (e) and (f) to fill in the entries of $A$ and $\vec{b}$, and solve for the unknowns.