EECS 16A   Designing Information Devices and Systems I
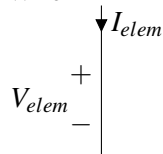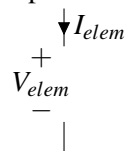## Summer 2023   Discussion 2B

1. Circuit Components and Ohm's Law

(a) We will look at the $I - V$ characteristics of different circuit components. For each of the components listed below, plot the $I_{elem} - V_{elem}$ characteristic curves.
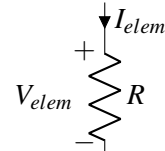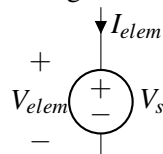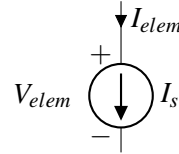
i. Wire
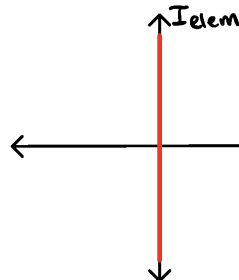
ii. Open Circuit

iii. Resistor

iv. Voltage Source

v. Current Source

Answer:

i. Wire

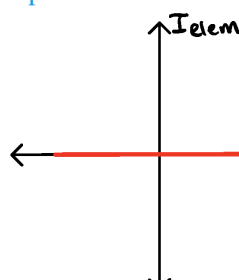ii. Open Circuit

iii. Resistor
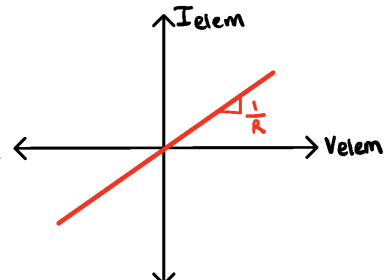
iv. Voltage Source
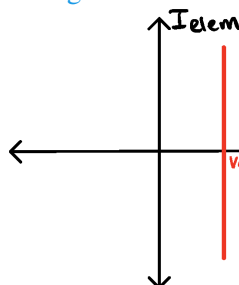
v. Current Source

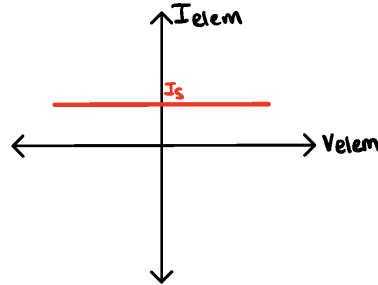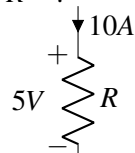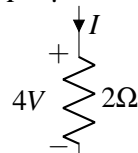(b) Use Ohm's Law to find the missing component values in the circuits below. You may assume that each circuit is part of a larger circuit where there is a closed path for current to flow.
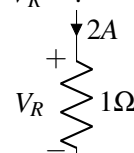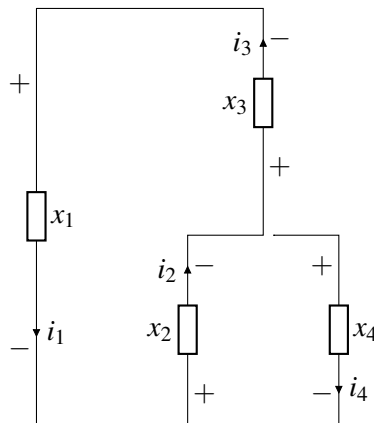
i. $R = ?$

 ii. $I = ?$

iii. $V_R = ?$

Answer:

i. $R = \frac{5V}{10A} = 0.5\Omega$

ii. $I = \frac{4V}{2\Omega} = 2A$

iii. $V = 2A \times 1\Omega = 2V$

2. Label the Nodes

(a) In the circuit shown above, identify and label all the nodes.

Answer:

Here are the nodes marked with different colors on the circuit diagram.

There are three nodes. We've labeled them as u_1, u_2, and u_3, but you can label them with any variables you want.
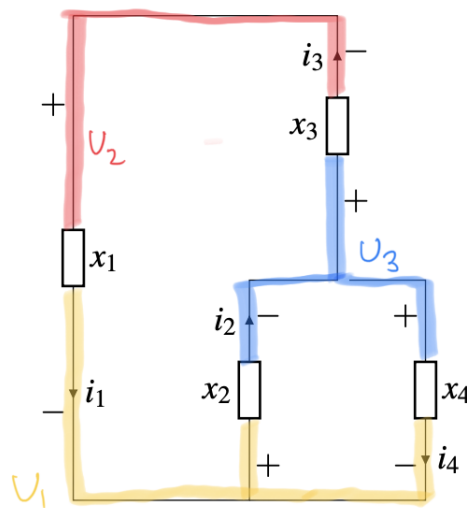
(b) Choose a node to be the reference node and find all the potentials across elements in the circuit in terms of the node potentials you labeled in the previous part

Answer: You can choose any node to be the reference node, but we will use u_1 in the diagram as ours in the example solution, so $u_1 = 0$. To find the voltage potential across an element, we subtract the node potential on the positive side of element by the node potential on the negative side of the element. Therefore, we get the following 4 equations:

$V_{x_1} = u_2 - 0 = u_2$

$V_{x_2} = 0 - u_3 = -u_3$

$$V_{x_3} = u_3 - u_2$$
$$V_{x_4} = u_3 - 0 = u_3$$

(c) (Optional) Write as many KCL equations as you can for the circuit.

Answer: There are 3 possible KCL equations, one for each node. To find each equation, for each node, add the current if it is going out of the node and subtract if it is going into the node. Adding all the currents this way will sum up to 0.

$$-i_1 + i_2 - i_4 = 0$$
$$-i_2 + i_3 + i_4 = 0$$
$$i_1 - i_3 = 0$$

(d) (Optional) Write as many KVL equations as you can for the circuit.

Answer: There are 3 possible KVL equations in the circuit. We will go in a counterclockwise loop, but going the other direction will also give you the same relations.

$$V_{x_1} + V_{x_3} + V_{x_2} = 0$$
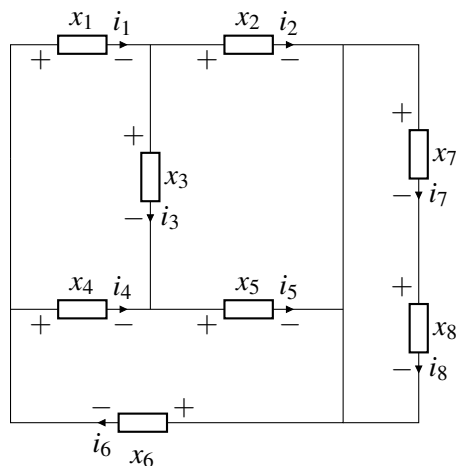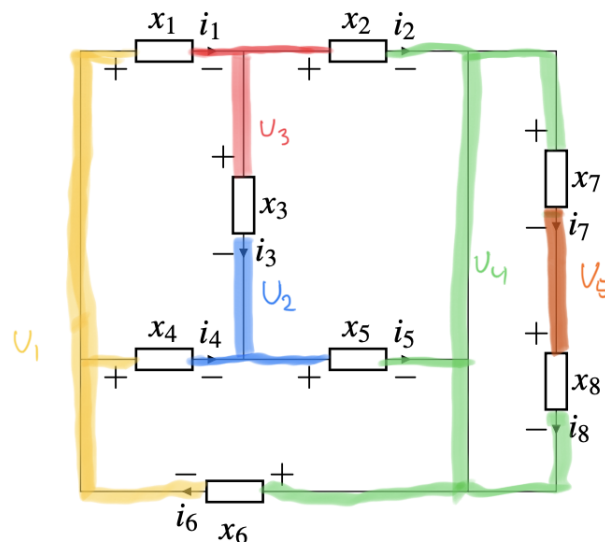$$V_{x_1} + V_{x_3} - V_{x_4} = 0$$
$$-V_{x_2} - V_{x_4} = 0$$

(e) In the circuit shown above, identify and label all the nodes.

Answer: Here are the nodes marked with different colors on the circuit diagram.

There are five nodes. We've labeled them as u_1, u_2, u_3, u_4 and u_5, but you can label them with any variables you want.

(f) Choose a node to be the reference node. What is the potential across the elements x_6 and x_7 in terms of node potentials you labeled in the previous part?

Answer: Once again, you can choose any node to be the reference node. We will choose u_1 again in our diagram. To find the voltage potential across an element, we subtract from the node potential on the positive side of element by the node potential on the negative side of the element.

For x_6, we have $V_{x_6} = u_4 - 0 = u_4$

For x_7, we have $V_{x_7} = u_4 - u_5$

(g) (Optional) Write a KCL equation involving i_1 and a KCL equation involving i_5.

Answer: There are 2 possible KCL equations for each current.

For i_1, we have:

$i_1 + i_4 - i_6 = 0$

$-i_1 + i_2 + i_3 = 0$

For i_5, we have:

$-i_3 - i_4 + i_5 = 0$

$-i_2 - i_5 + i_6 + i_7 - i_8 = 0$

(h) (Optional) Write a KVL equation involving V_{x_3} and a KVL equation involving V_{x_6}.

Answer: There are many possible KVL equations for each. As long as you follow a loop in the same direction, you will get a valid equation.

One possible KVL equation for V_{x_3} is

$V_{x_3} - V_{x_2} + V_{x_5} = 0$

One possible KVL equation for V_{x_6} is

$-V_{x_6} - V_{x_5} - V_{x_4} = 0$